

Naval Postgraduate School  
Monterey, California 93943-5138

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# Compilation of Theses Abstracts

December 2002



Office of the Associate Provost and Dean of Research  
Naval Postgraduate School

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## PREFACE

This publication contains unrestricted abstracts (unclassified and unrestricted distribution) of theses submitted for the degrees Aeronautical and Astronautical Engineer, Electrical Engineer, Mechanical Engineer, Master of Science, and Master of Arts for the December 2002 graduation. Classified and restricted distribution abstracts are listed on the NPS SIPRnet.

This compilation of abstracts of theses is published in order that those interested in the fields represented may have an opportunity to become acquainted with the nature and substance of the student research that has been undertaken. Copies of theses are available for those wishing more detailed information. The procedure for obtaining copies is outlined on the inside of the back cover.

For additional information on programs, or for a catalog, from the Naval Postgraduate School, contact the Director of Admissions.

Director of Admissions  
Code 01B3  
Naval Postgraduate School  
Monterey, CA 93943-5100  
Phone: (831) 656-3093  
Fax: (831) 656-3093  
The World Wide Web edition of the School's catalog is at:  
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Code 09  
Naval Postgraduate School  
Monterey, CA 93943-5100  
Phone: (831) 656-2099  
Fax: (831) 656-2038  
Email: [research@nps.navy.mil](mailto:research@nps.navy.mil)

The *Compilation of Theses Abstracts* can be found on-line at  
<http://web.nps.navy.mil/~code09/publications.html>.  
*NPS Research*, a tri-annual publication highlighting faculty and student research and *Summary of Research*, an annual publication of research projects and publications, are also available on-line.



# INTRODUCTION

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## Mission

The Naval Postgraduate School (NPS) was established to serve the advanced educational needs of the Navy. The broad responsibility of the school is reflected in its stated mission:

Increase the combat effectiveness of U.S. and allied armed forces and enhance the security of the U.S.A. through advanced education and research programs focused on the technical, analytical, and managerial tools needed to confront defense related challenges of the future.

To fulfill its mission, the Naval Postgraduate School strives to sustain excellence in the quality of its instructional programs, to be responsive to technological change and innovation in the Navy, and to prepare officers to introduce and utilize future technologies.

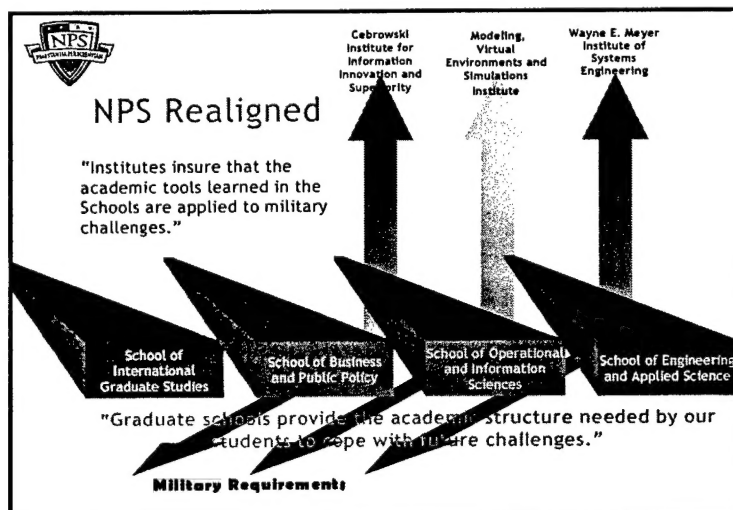
The research program at NPS exists to support the primary mission of graduate education. Research at NPS:

- maintains upper division course content and programs at cutting edge;
- challenges students with creative problem solving experiences on DoD relevant issues;
- advances DoN/DoD technology;
- solves warfare problems; and
- attracts and retains quality faculty.

## Academic Programs

To meet its educational requirements, the Navy has developed a unique academic institution at the Naval Postgraduate School through the use of specially tailored academic programs, and a distinctive organization trying academic disciplines to naval and joint warfighting applications.

The Naval Postgraduate School has realigned its education and supporting research programs to achieve three major goals: 1) academic programs that are nationally recognized and support the current and future operations of the Navy and Marine Corps, our sister services, and our allies; 2) institutes that focus on the integration of teaching and research in direct support of the four pillars of Joint Visions 2010 and 2020 and their enabling technologies; and, 3) executive and continuing education programs that support continuous intellectual innovation and growth throughout an officer's career.





# INTRODUCTION

Programs of Graduate Studies at NPS are grouped as follows:

## Graduate School of Operations and Information Sciences

- Computer Science
- Electronic Warfare International
- Information Systems and Operations
- Information Systems Technology
- Information Warfare
- Operations Analysis
- Operations Logistics
- Software Engineering
- Special Operations

## Graduate School of Engineering and Applied Sciences

- Aeronautical Engineering
- Aeronautical Engineering Avionics
- Combat Systems and Technology
- Electronic Systems Engineering
- Naval/Mechanical Engineering
- Meteorology
- Meteorology and Oceanography
- Reactors/Mechanical Engineering

## Graduate School of Business and Public Policy

- Systems Acquisition Management
- Financial Management
- Transportation Logistics Management
- Defense Systems Analysis
- Systems Inventory Management
- Information Systems Management
- Manpower Systems Analysis
- Transportation Management
- Leadership Education and Development
- Acquisition and Contract Management
- Program Management
- Material Logistics Support Management

## School of International Graduate Studies

- Area Studies
  - Middle East/Africa/South Asia
  - Far East/South-East Asia/Pacific
  - Western Hemisphere
  - Europe/Russia/Central Asia
- Civil-Military Relations
- Defense Decision Making and Planning
- Homeland Security Leadership Development
- International Security: Post Conflict Security Building

## Interdisciplinary Curricula

- Modeling, Virtual Environments, and Simulation
- Product Development
- Systems Engineering and Analysis
- Undersea Warfare
- Space Systems Engineering
- Space Systems Operations

## Students

The student body consists of U.S. officers from all branches of the uniformed services, civilian employees of the federal government and military officers and government civilian employees of other countries. Resident degree/subspecialty student population for December 2002 is shown in Figure 1.

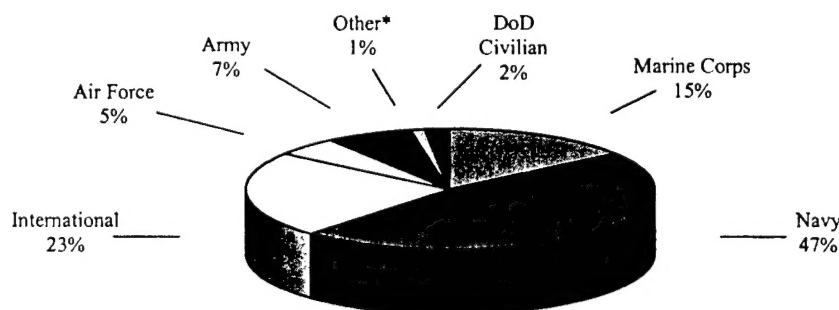


Figure 1: Resident Degrees/Subspecialty Student Population for December 2002  
(Total Enrollment: 1282)

\*National Guard/Coast Guard

# INTRODUCTION

## **Academic Degrees**

Although the curricula are tailored to address defense requirements, they are developed within the framework of classical academic degrees, meeting the highest academic standards. Each curriculum leads to a master's degree; however, additional study can lead to either an engineer's degree or the doctor's degree. Below is a listing of the degrees offered at NPS:

### **Master of Arts Degrees**

International Security and Civil-Military Relations  
National Security Affairs

### **Master of Business Administration**

### **Master of Science Degrees**

Aeronautical Engineering  
Applied Physics  
Applied Science  
Astronautical Engineering  
Computer Science  
Contract Management  
Defense Analysis  
Electrical Engineering  
Engineering Acoustics  
Engineering Science  
Information Systems and Operations  
Information Technology Management  
Joint Meteorology and Physical Oceanography  
Leadership and Human Resource Development  
Management  
Materials Science and Engineering  
Mechanical Engineering  
Meteorology  
Modeling, Virtual Environments, and Simulation  
Operations Research  
Physical Oceanography  
Physics  
Product Development

Program Management  
Software Engineering  
Space Systems Operations  
Systems Analysis  
Systems Engineering  
Systems Technology

### **Engineer Degrees**

Aeronautical and Astronautical Engineer  
Electrical Engineer  
Mechanical Engineer

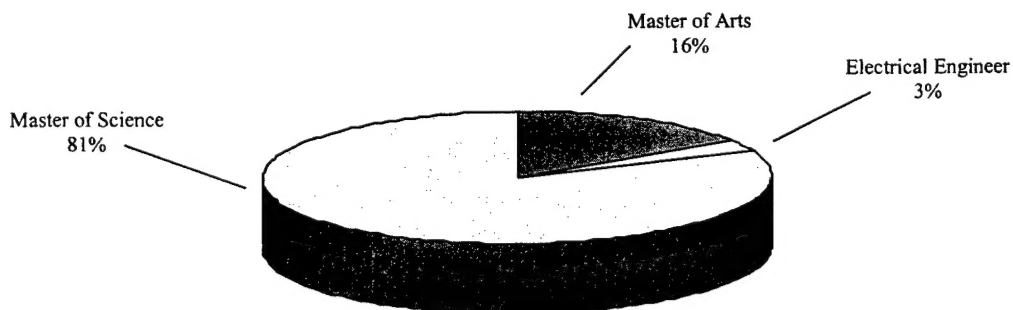
### **Doctor of Philosophy**

Aeronautical and Astronautical Engineering  
Applied Mathematics  
Applied Physics  
Computer Science  
Electrical Engineering  
Engineering Acoustics  
Mechanical Engineering  
Meteorology  
Modeling, Virtual Environments, and Simulation  
Operations Research  
Physics  
Software Engineering

### **Doctor of Engineering**

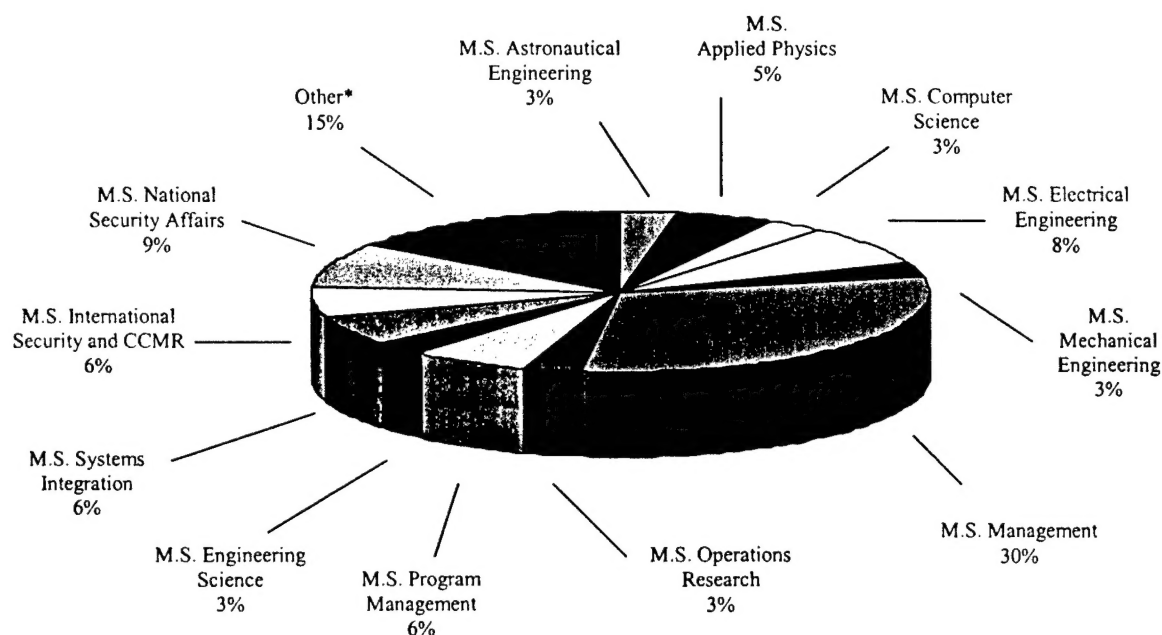
Aeronautical and Astronautical Engineering  
Engineering Acoustics  
Mechanical Engineering

There were 182 degrees conferred in December 2002. Figure 2 indicates the distribution of degree type; Figure 3 indicates the degree conferred.



**Figure 2. Distribution of Degree Type  
(182 Degrees Conferred)**

## INTRODUCTION



**Figure 3. Degrees Conferred in December 2002  
(182 Degrees Conferred)**

\*Aeronautical and Astronautical Engineer (3); Electrical Engineer (1); Mechanical Engineer (2); M.S. Aeronautics (2); M.S. Defense Analysis (3); M.S. Contract Management (2); M.S. Engineering Acoustics (2); M.S. Information Technology Management (2); M.S. Meteorology and Oceanography (1); M.S. Oceanography (1); M.S. Physics (3); M.S. Software Engineering (2); M.S. Space Operations (1); M.S. Systems Engineering (2)

### **Thesis**

The thesis is the capstone achievement of the student's academic endeavor at NPS. Thesis topics address issues from the current needs of the Fleet and Joint Forces to the science and technology that is required to sustain long-term superiority of the Navy/DoD.

Students, with their faculty advisors, provide a very unique capability within the DoD for addressing warfighting problems. This capability is especially important at the present time when technology in general, and information operations in particular, are changing rapidly. Our officers must be able to think innovatively and have the knowledge and skills that will let them apply technologies that are rapidly being developed in both the commercial and military sectors. Their unique knowledge of operations, when combined with a challenging thesis project which requires them to apply their focused graduate education, is one of the most effective methods for both solving Fleet/Joint Force problems and instilling the life-long capability for applying basic principles to the creative solution of complex problems.

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## **ADVANCED DEGREES**

**Aeronautical and Astronautical Engineer  
Electrical Engineer  
Mechanical Engineer**





# **AERONAUTICAL AND ASTRONAUTICAL ENGINEER**

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## **DEVELOPMENT OF PRECISION POINTING CONTROLLERS WITH AND WITHOUT VIBRATION SUPPRESSION FOR THE NPS PRECISION POINTING HEXAPOD**

**Ronald M. Bishop, Jr.-Lieutenant Commander, United States Navy**

**B.S., United States Naval Academy, 1991**

**Aeronautical and Astronautical Engineer-December 2002**

**Master of Science in Astronautical Engineering-December 2002**

**Advisor: Brij N. Agrawal, Department of Aeronautics and Astronautics**

**Second Reader: Hong-Jen Chen, National Research Council Research Associate**

Satellite optical payloads demand better vibration control and finer precision pointing than ever before. Fortunately, the Stewart-Gough platform offers the potential of accomplishing both of these simultaneously.

Using the Precision Pointing Hexapod at NPS (a Stewart-Gough platform), several controllers for precision pointing, with and without vibration disturbances, were developed. Unlike the traditional means of pointing a hexapod, (i.e. sensing and controlling strut length to orient payload), this research used the payload orientation derived from payload mounted position sensors to determine orientation and provide feedback to the actuator controller. Small and large angle controllers were developed and evaluated for accuracy using static pointing and dynamic tracking tasks. The pointing controllers were then added to an Adaptive Disturbance Canceller and evaluated for pointing accuracy and vibration suppression performance given a single tone disturbance.

The results showed a static pointing accuracy of  $\pm 0.008^\circ$  and a dynamic pointing accuracy ranging from  $\pm 0.05^\circ$  to  $\pm 0.2^\circ$ , depending on the size and speed of the circular trajectory. Vibration suppression down to the noise floor was achieved in all static orientations tested. As for dynamic circle-tracking performance, at least a 20 dB reduction in the fundamental disturbance was obtained without degradation in pointing accuracy.

**KEYWORDS:** Precision Pointing, Hexapod, Stewart Platform, Vibration Suppression, Adaptive Disturbance Canceller

## **DESIGN OF OPTIMAL CYCLERS USING SOLAR SAILS**

**Robert E. Stevens-Lieutenant Commander, United States Navy**

**B.S., United States Naval Academy, 1989**

**Aeronautical and Astronautical Engineer-December 2002**

**Master of Science in Astronautical Engineering-December 2002**

**Advisor: I. M. Ross, Department of Aeronautics and Astronautics**

**Second Reader: Dennis V. Byrnes, Jet Propulsion Lab**

Ongoing interest in establishing a base on Mars has spurred a need for regular and repeated visits to the red planet using a cycling shuttle to transport supplies, equipment and to retrieve surface samples. This thesis presents an approach to designing an optimal heliocentric cycling orbit, or cycler, using solar sails. Results show that solar sails can be used to significantly reduce  $V_\infty$ s at Mars and Earth. For example, using a reasonably high performance solar sail, a  $V_\infty|_{Mars} = 2.5$  km/s is possible at every synodic period using a two-dimensional orbit model. Lower performance sails were also modeled resulting in paths that behaved more like a ballistic Aldrin cycler with higher  $V_\infty$ s. Double rendezvous missions were explored where the spacecraft must match the velocities of both Earth and Mars, offering promising trajectories for Mars sample return missions. The solutions to these missions, although not necessarily cyclers, show that using a sail to rendezvous with and remain near Mars for an optimal amount of time will minimize the total

## **AERONAUTICAL AND ASTRONAUTICAL ENGINEER**

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transit time between Earth and Mars. General-purpose dynamic optimization software, DIDO, is used to solve the optimal control problem using a pseudospectral method using both two- and three-dimensional elliptic orbit models.

**KEYWORDS:** Cycler Trajectory, Solar Sail, Optimal Design, DIDO, Mars Mission, Trajectory Design, Cycling Orbits

### **AN IMPROVED ALGEBRAIC GRID GENERATOR FOR NUMERICAL AERODYNAMIC ANALYSES OF AIRFOIL CROSS-SECTIONS**

**Justin M. Verville-Lieutenant, United States Naval Reserve**

**B.S., Purdue University, 1995**

**Aeronautical and Astronautical Engineer-December 2002**

**Advisor: Kevin Jones, Department of Aeronautics and Astronautics**

**Co-Advisor: Max Platzer, Department of Aeronautics and Astronautics**

Although computer-processing power has increased dramatically over the past few decades, minimizing computation time is still critical when conducting numerical aerodynamic analyses. One area where this is evident is the grid generation routines used in most code for this area of research. While many more sophisticated grid generation techniques are available, algebraic grid generation is still in use today due strictly to efficiency. Computational efficiency is of particularly great concern during analyses that involve motion of the surface being analyzed, since computing a new grid at each time step is often required. Unfortunately however, few if any, algebraic grid generation routines exist that are powerful enough to produce a grid with no overlapping gridlines and minimal distortion, yet still minimize computation time. As a result, the purpose of this thesis was to design such a routine. The end result is a C-Grid generating routine with a Graphical User Interface (GUI) called Astro Grid.

**KEYWORDS:** Algebraic Grid Generator, Aeronautical Engineering, Navier-Stokes, Flow Solver, Numerical Aerodynamic Analyses, Airfoil Cross-Section, Computational Fluid Dynamics, CFD

# **ELECTRICAL ENGINEER**

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## **FACE RECOGNITION USING INFRARED IMAGING**

**Diogo C. Pereira-First Lieutenant, Brazilian Air Force  
B.S.E.E., Instituto Tecnológico de Aeronautica, Brazil, 1994  
Electrical Engineer-December 2002**

**Master of Science in Electrical Engineering-December 2002**

**Thesis Supervisor: Monique P. Fargues, Department of Electrical and Computer Engineering**

**Thesis Co-Supervisor: Gamani Karunasiri, Department of Physics**

**Thesis Committee Member: Roberto Cristi, Department of Electrical and Computer Engineering**

This study investigated an infrared (IR) face recognition system using an uncooled IR camera. A computer-based image collection set-up was designed and used to create a small database of 420 facial images, from 14 volunteers. Manual and automated facial image cropping routines were implemented. Two linear approaches for the dataset dimension reduction and classification were implemented and their resulting classification performances compared: PCA-based and LDA approaches. Results show that the best PCA-based average classification performance is equal to 92.22% while the LDA-based classification performance is equal to 99.40%. These results successfully show that an uncooled IR camera may be used to discriminate between individual subjects obtained from a small database collected under a very controlled environment.

**KEYWORDS:** Face Recognition, Classification, PCA, LDA, IR, Infrared, Eigenvectors



# MECHANICAL ENGINEER

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## TRACKING CONTROL OF AUTONOMOUS UNDERWATER VEHICLES

Joseph J. Keller-Lieutenant, United States Navy

B.S.M.E., San Diego State University, 1994

Mechanical Engineer-December 2002

Master of Science in Mechanical Engineering-December 2002

Advisor: Anthony J. Healey, Department of Mechanical Engineering

Recovery of Autonomous Underwater Vehicles (AUVs) can often be an autonomous operation itself. In the case of an AUV that is launched and recovered at some significant depth below the surface, the recovery platform to which the vehicle will dock is often not a stationary platform. The recovery cage/platform has dynamics associated with it which are induced by wave motion effects on the ship to which the cage is tethered. In order to successfully recover a vehicle into a cage platform it will be preferred for the vehicle to have the capability to compensate for this motion when making its final approach to the cage. Using active compensation, a smaller cage can be utilized for recovery of an AUV. This research attempts to investigate a means by which a vehicle may be made to track, in depth, dynamic motion with zero phase lag between the vehicle and the recovery platform utilizing an error space controller.

**KEYWORDS:** Underwater Vehicle, AUV, Tracking, Control, Error Space Control, AUV Parameter Identification, AUV Recovery



## **MASTER OF SCIENCE**

**Aeronautical Engineering  
Applied Physics  
Astronautical Engineering  
Computer Science  
Contract Management  
Defense Analysis  
Electrical Engineering  
Engineering Acoustics  
Information Technology Management  
Management  
Mechanical Engineering  
Meteorology and Physical Oceanography  
Oceanography  
Operations Research  
Physics  
Program Management  
Software Engineering**





# **MASTER OF SCIENCE IN AERONAUTICAL ENGINEERING**

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## **DESIGN RECOVERY AND IMPLEMENTATION OF THE AYK-14 VHSIC PROCESSOR MODULE ADAPTER WITH FIELD PROGRAMMABLE GATE ARRAY TECHNOLOGY**

**Bryan J. Fetter-Lieutenant, United States Navy**

**B.S., United States Naval Academy, 1993**

**Master of Science in Aeronautical Engineering-December 2002**

**Advisor: Russell W. Duren, Department of Aeronautics and Astronautics**

**Second Reader: Herschel H. Loomis, Jr., Department of Electrical and Computer Engineering**

The rapid pace of change in the electronics industry and the significant reduction in military budgets over the past decade has forced many military aircraft to extend their service lifetimes. This has led to aircraft with outdated avionics systems being required to accomplish new and more complex missions. This thesis examines the process of reengineering an outdated avionics system to economically upgrade its capabilities through the FPGA implementation of a binary compatible replacement. The system targeted is the AN/AYK-14(V) Navy Standard Airborne Computer, specifically the XN-8 chassis used as the mission computer onboard the F/A-18 C/D aircraft. This thesis is also intended to provide a resource document on the AYK-14 for a study being conducted by the Naval Air Systems Command (NAVAIR) Advanced Weapons Laboratory (AWL). The design of the Input/Output module of the VHSIC Processor Module was recovered through research of documentation and hardware testing. The recovered design was modeled using VHDL, synthesized and implemented using commercially available software. This thesis shows that replacement of legacy systems through use of FPGA technology is a viable option, however, expansion of the design is recommended to create a truly binary compatible replacement.

**KEYWORDS:** Obsolescence, Legacy, FPGA, VHDL, VHSIC, Xilinx, SDRAM, AYK-14, Mil-Std-1553, State Machine, AVNET, Bus Controller, Data Bus, Software Interrupts, Reengineering, Design Recovery



# **MASTER OF SCIENCE IN APPLIED PHYSICS**

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## **HIGH ENERGY LASERS FOR SHIP-DEFENSE AND MARITIME PROPAGATION**

**Vasileios Bouras-Lieutenant, Hellenic Navy  
B.S., Hellenic Naval Academy, 1993**

**Master of Science in Applied Physics-December 2002**

**Master of Science in Electrical Engineering-December 2002**

**Advisor: William B. Colson, Department of Physics**

**Co-Advisor: Phillip E. Pace, Department of Electrical and Computer Engineering**

High Energy Lasers (HELs) are a new class of weapons that may be of great value to the Navy in the near future. A high-power Free Electron Laser (FEL) is being designed using short Rayleigh-length resonators to increase the spot size at the mirrors and hence avoid mirror damage. Three-dimensional simulations are used to study the effects of an electron beam misalignment (electron beam tilt). This thesis shows that the proposed design is tolerant of typical electron beam misalignments. The performance of a step-tapered undulator is also studied for the 100 kW proposed upgrade of the Jefferson Laboratory FEL. The results of this research show that the gain is above the required threshold for the 100 kW design while the energy spread does not change significantly over any undulator design. The spectrum of the proposed FEL shows that most of the power is concentrated around the fundamental frequency. It is shown in this thesis that smooth FEL pulses can significantly reduce the negative effects of absorption and scattering. Recent HEL science and technology developments are discussed for both Free Electron and Solid-State Lasers.

**KEYWORDS:** Free Electron Laser, Solid-state Lasers, High Energy Lasers, Short Rayleigh Length, Step-taper Undulator, SSHCL, Laser Propagation

## **ACTIVE MIRROR ALIGNMENT FOR FREE ELECTRON LASERS**

**Fulvia M. Fiorani-Lieutenant Commander, United States Navy**

**B.S., Embry-Riddle Aeronautical University, 1991**

**M.S., Embry-Riddle Aeronautical University, 2000**

**Master of Science in Applied Physics-December 2002**

**Advisor: Bruce C. Denardo, Department of Physics**

**Second Reader: Thomas J. Hofler, Department of Physics**

This thesis investigates active mirror alignment systems of a free electron laser (FEL) for future integration as a ship self-defense weapon. An issue with this integration is the effect of low-frequency shipboard vibrations on the optical cavity mirrors. Alignment of the cavity mirrors is required for the proper operation of any type of laser. Mirror alignment is especially critical for an FEL because the electron beam and optical mode must substantially overlap. Laboratory FEL facilities, along with other laboratory high energy facilities that employ active mirror alignment systems, are investigated. In addition, a model theory for controlling the vibrations of a single-degree-of-freedom system is developed, and experiments with a simple mirror alignment system are described. Reduction of an impressed vibration amplitude by a factor of five is achieved, compared to a factor of fifteen that is achieved in major laboratory systems with sophisticated control systems. The purpose of these efforts is to understand the underlying physics of vibration control. The knowledge forms a basis for follow-on research towards the development of a prototype shipboard active mirror alignment system.

**KEYWORDS:** Free-Electron Lasers, Directed Energy Weapons, Active Control, Vibration Stabilization

## APPLIED PHYSICS

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### DESIGN AND FIRST OPERATIONS OF THE LINEATE IMAGING NEAR-ULTRAVIOLET SPECTROMETER (LINUS)

Jean M. Gray-Lieutenant, United States Navy

B.S., United States Naval Academy, 1996

Master of Science in Applied Physics-December 2002

Advisor: Richard C. Olsen, Department of Physics

Second Reader: Richard Harkins, Department of Physics

Spectral imagery provides a new technology for target detection, defeat of camouflage, concealment and deception, and detection of chemical/biological agents in the atmosphere. The Lineate Imaging Near Ultraviolet Spectrometer (LINUS) is designed to image a narrow passband in the UV portion of the Electromagnetic spectrum. The imaging spectrometer views a 0.5 degree vertical strip, while observing a 20-40 nm wide band currently centered at 300 nm. The 512 x 512 pixel focal plane provides 0.1-1.0 nm spectral resolution, depending on slit width in the dispersive optic instrument. It is designed to scan a 2.5 degree horizontal pattern. The instrument has been calibrated spectrally, and its response to sulfur dioxide has been measured. First observations with the scanning instrument in the laboratory and outdoors at NPS are presented. This work demonstrates that LINUS can detect SO<sub>2</sub> down to concentrations less than 100 ppm.

**KEYWORDS:** Sulfur Dioxide, Gas Detection, Ultraviolet (UV), Imaging Spectrometry, Lineate Imaging Near Ultraviolet Spectrometer (LINUS), Spectral Imaging

### COMPUTER-CONTROLLED PHOTODETECTOR CHARACTERIZATION SYSTEM (DESIGN AND CONSTRUCTION)

Bryan E. Herdlick-Lieutenant Commander, United States Navy

B.S.E.E., University of Dayton, 1986

Master of Science in Applied Physics-December 2002

Advisor: Gamani Karunasiri, Department of Physics

Second Reader: Scott Davis, Department of Physics

This system was designed to evaluate the response characteristics of photodetectors operating at wavelengths in the 1 micron and 8-12 micron range. A Quartz-Tungsten-Halogen source was used for visible and near-IR energy, and a dedicated IR element provided gray-body radiation with a peak at 1150 Kelvin. A monochromator was employed in conjunction with a six-position filter wheel to provide precise control of energy incident on the photodetectors. Variations in the efficiency of components were compensated for through normalization based on the energy incident on the photodetectors. An intuitive, computer-based interface was developed to automate data collection, and provided numeric and graphic representations of data as it is being collected. At completion, data is exported to a spreadsheet file. A commercial silicon detector was successfully characterized, and accurate voltage response and responsivity curves were generated. A pyroelectric detector was used to verify proper operation of gratings and filters at infrared wavelengths. The system is suitable for its intended purpose, and will be capable of characterizing detectors designed to operate in the 3-5 micron range with the installation of appropriate filters and gratings.

**KEYWORDS:** Detector, Photodetector, QWIP, Responsivity, Monochromator, Characterization, Characteristic Response, Detectivity, LabVIEW, Virtual Instrument, Optics, Photonics.

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### FREE ELECTRON AND SOLID STATE LASERS DEVELOPMENT FOR NAVAL DIRECTED ENERGY

Aristeidis Kalfoutzos-Lieutenant, Hellenic Navy

B.S., Hellenic Naval Academy, 1993

Master of Science in Applied Physics-December 2002

Master of Science in Electrical Engineering-December 2002

Advisor: William B. Colson, Department of Physics

Second Reader: Phillip E. Pace, Department of Electrical and Computer Engineering

A MW level FEL is being designed with a short a Rayleigh length resonator to increase the spot size at the mirrors and to avoid mirror damage. In this thesis, it is found that it is desirable to focus the electron beam to improve the FEL extraction efficiency. Three-dimensional simulations show that the focused electron beam increases the extraction efficiency far beyond the required value of 0.7%. It is also found in this thesis that shifting the electron beam off-axis less than 0.3 mm, the efficiency remains above the required value. The proposed FEL design uses high power, short optical pulses whose spectrum may cover many absorption lines. The absorbed laser energy can heat up the air resulting in defocusing the laser beam (thermal blooming). This thesis shows that thermal blooming is not an issue for a moderate clear atmosphere when the stagnation zone size remains less than 10 m. A transitional step for the development of a MW level FEL weapon is the proposed 100 kW upgrade of the Thomas Jefferson National Accelerator Facility's FEL. It has also been shown in this thesis that the use of a step-taper undulator slightly improves the performance of the FEL. Finally, the potential of various high average power solid-state laser designs are reviewed.

**KEYWORDS:** Free Electron Laser, Propagation of High Power Free Electron Laser Pulses, Thermal Blooming, Focused Electron and Optical Beams, Desynchronism, Step-taper Undulator, High Power Solid-state Laser

### 3D VISUALIZATION OF INVARIANT DISPLAY STRATEGY FOR HYPERSPECTRAL IMAGERY

Kang Suk Kim-Captain, Korean Army

B.S., Korea Military Academy, 1994

Master of Science in Applied Physics-December 2002

Master of Science in Computer Science-December 2002

Advisors: Richard C. Olsen, Department of Physics

Donald P. Brutzman, Department of Information Science

Spectral imagery provides multi-dimensional data, which are difficult to display in standard three-color image formats. Tyo, et al. (2001) propose an invariant display strategy to address this problem. This approach is to mimic the dynamics of human perception. The dimensionality of the data are reduced by using a Principal Component (PC) transformation, and then displayed by making use of a Hue, Saturation, and Value (HSV) display transform.

This study addresses the PC transformation strategy, looks for a global eigenvector via 3D visualization of HSV color space information, and examines the suggested algorithm to provide the most intuitive display. The user interface created in this thesis is capable of computing the necessary implementation of the proposed strategy, viewing selected Region of Interest (ROI) in HSV color space model in 3D, and viewing the 2D resultant image. A demonstration application uses Java language including Java2D, Xj3D Player, Document Object Model (DOM) Application Program Interfaces (API), and Extensible 3D Language (X3D). The Java2D API enables the user to load imagery, process data, and render results in a two-dimensional (2D) view. Xj3D and DOM APIs are introduced to visualize Tyo's invariant display strategy in three-dimensional (3D) views and then to save results as X3D scenes. These techniques appear to be inherently valuable and can serve as the basis for further research.

Through this thesis, 3D visualization of the proposed algorithm successfully showed PC transformed data does form a conical shape in HSV color space. Also, a comparison of PC transformed data with HSV color space revealed the hue angle needed to be adjusted. The application of this adjustment to multiple

scenes produced consistent results. However, this hue adjustment left other scene elements in non-ergonomic colors and brought up the issue of further enhancement of the algorithm.

**KEYWORDS:** Hyperspectral Imagery, 3D Visualization, X3D, Java Xj3D Player

### **BARREL WEAR REDUCTION IN RAIL GUNS: AN INVESTIGATION OF SILVER PASTE LIQUID-METAL INTERFACE**

**Michael Willet Smith, Jr.-Lieutenant, United States Navy  
B.S., Southern A&M University, 1998**

**Master of Science in Applied Physics-December 2002**

**Thesis Advisor: William B. Maier, II, Department of Physics**

**Thesis Co-Advisor: Donald Snyder, Department of Physics**

**Second Reader: Richard Harkins, Department of Physics**

This thesis tests the effects a commercial silver paste has on the damage at the projectile-rail interface of a 4" long rail gun test section. Projectiles (0.635 x 0.635 x 0.953 cm) were pushed through the rail test section at  $34 \pm 19$  m/s, while average current densities of 18-30 kA/cm<sup>2</sup> was passed through the projectile – rail interface material. The specific objective is to examine rail and projectile damage at current densities near or above those ( $\approx 25$  kA/cm<sup>2</sup>) anticipated for a naval rail gun. Voltages across the rails were monitored and changes in conductivity when solid electrical contact was broken were observed. Silver deposits were observed on the rails from the paste at a peak current of 13.3 kA, while no damage was seen on the rails until a peak current of 17.2 kA was reached, which corresponds to average current densities of 22 kA/cm<sup>2</sup> and 28.5 kA/cm<sup>2</sup>, respectively.

**KEYWORDS:** Rail Gun, Railgun, Sliding Contact, Electrical Contact, Conductive Interface, Silver Paste, Rail Erosion, Projectile Diagnostics

# **MASTER OF SCIENCE IN ASTRONAUTICAL ENGINEERING**

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## **DEVELOPMENT OF PRECISION POINTING CONTROLLERS WITH AND WITHOUT VIBRATION SUPPRESSION FOR THE NPS PRECISION POINTING HEXAPOD**

**Ronald M. Bishop, Jr.-Lieutenant Commander, United States Navy  
B.S., United States Naval Academy, 1991**

**Aeronautical and Astronautical Engineer-December 2002**

**Master of Science in Astronautical Engineering-December 2002**

**Advisor: Brij N. Agrawal, Department of Aeronautics and Astronautics**

**Second Reader: Hong-Jen Chen, National Research Council Research Associate**

Satellite optical payloads demand better vibration control and finer precision pointing than ever before. Fortunately, the Stewart-Gough platform offers the potential of accomplishing both of these simultaneously.

Using the Precision Pointing Hexapod at NPS (a Stewart-Gough platform), several controllers for precision pointing, with and without vibration disturbances, were developed. Unlike the traditional means of pointing a hexapod, (i.e. sensing and controlling strut length to orient payload), this research used the payload orientation derived from payload mounted position sensors to determine orientation and provide feedback to the actuator controller. Small and large angle controllers were developed and evaluated for accuracy using static pointing and dynamic tracking tasks. The pointing controllers were then added to an Adaptive Disturbance Canceller and evaluated for pointing accuracy and vibration suppression performance given a single tone disturbance.

The results showed a static pointing accuracy of  $\pm 0.008^\circ$  and a dynamic pointing accuracy ranging from  $\pm 0.05^\circ$  to  $\pm 0.2^\circ$ , depending on the size and speed of the circular trajectory. Vibration suppression down to the noise floor was achieved in all static orientations tested. As for dynamic circle-tracking performance, at least a 20 dB reduction in the fundamental disturbance was obtained without degradation in pointing accuracy.

**KEYWORDS:** Precision Pointing, Hexapod, Stewart Platform, Vibration Suppression, Adaptive Disturbance Canceller

## **DEVELOPMENT AND CONTROL OF ROBOTIC ARMS FOR THE NAVAL POSTGRADUATE SCHOOL AUTONOMOUS DOCKING SIMULATOR (NPADS)**

**Gary L. Cave-Lieutenant, United States Navy  
B.S., Georgia Institute of Technology, 1996**

**Master of Science in Astronautical Engineering-December, 2002**

**Advisor: Michael G. Spencer, Department of Aeronautics and Astronautics**

**Second Reader: Brij N. Agrawal, Department of Aeronautics and Astronautics**

This thesis encompasses the development of two robotic arms for integration onto the Naval Postgraduate School (NPS) Planar Autonomous Docking Simulator (NPADS) servicing vehicle. This research effort involved support structure design, fabrication, and construction, off-the-shelf motion control hardware integration, and control algorithm development and testing.

The NPADS system is being built as a test platform for spacecraft docking and capture mechanisms designed for autonomous rendezvous and servicing missions. As with the servicing vehicle, the robotic arms utilize a floatation system on an air-bearing granite table to provide a two-dimensional, drag-free environment. DC brushless servo motors serve as shoulder, elbow, and wrist joints allowing planar motion of the two-link arms. A National Instruments (NI) PXI computer and Motion Control card provide system processing and the software to hardware interface. The NI LabVIEW software suite enabled development



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of manual control code and autonomous control subroutines compatible with the control software of the NPADS main body. A single, wrist-mounted CCD bullet camera provides visual target acquisition for the robotic arm control system.

Testing and analysis were completed in the NPS Satellite Servicing Laboratory on a table-based test harness to facilitate initial design iteration.

**KEYWORDS:** Motion Control, Robotic Arm, LabVIEW, Autonomous Docking, Satellite Simulator, DC Brushless Servo Motors

### SPACECRAFT POWER BEAMING AND SOLAR CELL ANNEALING USING HIGH-ENERGY LASERS

**Richard C. Luce, Jr.-Captain, United States Air Force**

**B.S., United States Air Force Academy, 1993**

**M.S., University of Central Florida, 1999**

**Master of Science in Astronautical Engineering-December 2002**

**Advisor: Sherif Michael, Department of Electrical and Computer Engineering**

**Co-Advisor: Oscar Biblarz, Department of Aeronautics and Astronautics**

Satellite lifetime is often limited by degradation of the electrical power subsystem--radiation-damaged solar arrays and failed batteries. Being able to beam power from terrestrial sites could alleviate this limitation, extending the lifetime of billions of dollars of satellite assets, as well as providing additional energy for electric propulsion that can be used for stationkeeping and orbital changes. In addition, laboratory research at the Naval Postgraduate School (NPS) has shown the potential to anneal damaged solar cells using lasers. This thesis describes that research, preliminary work performed lasing a representative solar panel array, and a proposed on-orbit experiment to demonstrate the relevant concepts by lasing PANSAT, an NPS-built and operated spacecraft.

The preliminary work done at Maui involved lasing a PANSAT silicon photovoltaic array using a 975 nm Yb:YAG source at output power levels of 7 W, 14 W and 21 W. These results matched those obtained under near-AM0 conditions atop Mount Haleakala (for the 7 W case) and extrapolated to match predicted output levels. Enough data points were collected at each power level to generate an I-V curve for the panel, identifying the open circuit voltage, short circuit current, and maximum power points. The efficiency of the panel varied from 13.1% (as expected for monochromatic light) at 7 W to 11.3% at 21 W due to uniform heating of the cells. These results represent a "ground truth" baseline from which further research can continue.

**KEYWORDS:** Laser, Solar Cell, Photovoltaics, Power Beaming, Annealing, Wireless Power Transmission, Electric Propulsion, PANSAT

### DESIGN OF OPTIMAL CYCLERS USING SOLAR SAILS

**Robert E. Stevens-Lieutenant Commander, United States Navy**

**B.S., United States Naval Academy, 1989**

**Aeronautical and Astronautical Engineer-December 2002**

**Master of Science in Astronautical Engineering-December 2002**

**Advisor: I. M. Ross, Department of Aeronautics and Astronautics**

**Second Reader: Dennis V. Byrnes, Jet Propulsion Lab**

Ongoing interest in establishing a base on Mars has spurred a need for regular and repeated visits to the red planet using a cycling shuttle to transport supplies, equipment and to retrieve surface samples. This thesis presents an approach to designing an optimal heliocentric cycling orbit, or cycler, using solar sails. Results show that solar sails can be used to significantly reduce  $V_{\infty}$  at Mars and Earth. For example, using a reasonably high performance solar sail, a  $V_{\infty}|_{Mars} = 2.5$  km/s is possible at every synodic period using a two-dimensional orbit model. Lower performance sails were also modeled resulting in paths that behaved more like a ballistic Aldrin cycler with higher  $V_{\infty}$ s. Double rendezvous missions were explored where the

spacecraft must match the velocities of both Earth and Mars, offering promising trajectories for Mars sample return missions. The solutions to these missions, although not necessarily cyclers, show that using a sail to rendezvous with and remain near Mars for an optimal amount of time will minimize the total transit time between Earth and Mars. General-purpose dynamic optimization software, DIDO, is used to solve the optimal control problem using a pseudospectral method using both two- and three-dimensional elliptic orbit models.

**KEYWORDS:** Cycler Trajectory, Solar Sail, Optimal Design, DIDO, Mars Mission, Trajectory Design, Cycling Orbits

### INITIATOR DIFFRACTION LIMITS FOR PULSE DETONATION ENGINE OPERATION

Steven P. Werner-Lieutenant, United States Navy

B.S., United States Naval Academy, 1996

Master of Science in Astronautical Engineering-December 2002

Advisor: Christopher M. Brophy, Department of Aeronautics and Astronautics

Second Reader: Jose O. Sinibaldi, Department of Aeronautics and Astronautics

Operational characteristics of a valveless pulse detonation engine system are being characterized by both experimental and computational efforts. The detonation diffraction process from a small "initiator" combustor to a larger diameter main combustor in a continuous airflow configuration was evaluated during multi-cycle operation of a pulse detonation engine. The multi-cycle detonation experiments were performed on an axisymmetric engine geometry operating on both ethylene and propane fuel/air mixtures. The new design explored the effect of forward relief area on performance and its ability to isolate the detonation products from the incoming air flow during cyclic operation.

The use of a small fuel-oxygen initiator to initiate a fuel/air detonation in a larger main combustor has been achieved and has demonstrated the benefit of generating an overdriven detonation condition near the diffraction plane for enhanced transmission to a larger combustor. Mach reflections have been observed on the outer wall downstream of the diffraction plane for the two-dimensional geometry and appear to be the primary re-initiation mechanisms for the re-established fuel-air detonations for this geometry. Multi-cycle tests have successfully evaluated initiator/main combustor diameter ratios of up to 1.58 and are expected to continue through 2.0.

**KEYWORDS:** Pulse Detonation Engine, Detonation, Valveless, Space Propulsion, Hydrocarbon Fuels



# **MASTER OF SCIENCE IN COMPUTER SCIENCE**

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## **FRAMEWORK FOR MANAGING METADATA SECURITY TAGS AS THE BASIS FOR MAKING SECURITY DECISIONS**

**Panagiotis Aposporis-Major, Hellenic Air Force  
B.S., Hellenic Air Force Academy, 1989**

**Master of Science in Computer Science-December 2002**

**Advisor: Ted G. Lewis, Department of Computer Science**

**Co-Advisor: Timothy E. Levin, Department of Computer Science**

This thesis presents an analysis of a capability to employ CAPCO (Controlled Access Program Coordination Office) compliant Metadata security tags as the basis for making security decisions. This research covers all the security aspects of the related technologies, such as XML, Web Services, Java API's for XML, .NET Architecture to help determine how security conscious enterprises such as the Intelligence Community can implement this approach in the real insecure world, with commercial-off-the-self products, to meet their needs. There were many concerns about using the XML Metadata Label Tags as the basis for making security decisions, due to an untrusted environment. By using appropriate trusted parts, when really necessary, and new technologies, secure solutions for creating, storing and disseminating XML documents can be found.

Besides the theoretical research, this thesis also presents a prototype development of a Web Service that can handle most of the tasks (save, save locally, review, etc.), which are required to securely manage XML documents. In order to implement the above Web Service, open source products, such as Java and Apache Tomcat Web Server, are used. These are not only available free, easily testable and commonly used, but they provide a great interoperability among almost all the platforms. The implementation can also be done by using other competitive technologies or platforms or can even use similar or related commercial products.

**KEYWORDS:** Metadata, Web Service, XML, XSL, DTD, Schema, SAX, Security, Policy, XML Editor, XML Parser, Validate, Security Attributes, Labels, Objects

## **PERFORMANCE EVALUATION OF VOICE OVER INTERNET PROTOCOL**

**Chaiporn Dechjaroen-Major, Royal Thai Army**

**B.S., Chulachomklao Royal Military Academy, 1991**

**Master of Science in Computer Science-December 2002**

**Advisor: Geoffrey Xie, Department of Computer Science**

**Second Reader: Bert Lundy, Department of Computer Science**

Voice over Internet Protocol (VoIP) was developed to emulate toll services with lower communication cost. In VoIP applications, voices are digitized and packetized into small blocks. These voice blocks are encapsulated in a sequence of voice packets using the Real-time Transport Protocol (RTP) and delivered by the User Datagram Protocol (UDP). To help VoIP applications deal with unpredictable network performance, the Real-time Transport Control Protocol (RTCP) is developed to monitor the performance of RTP packets and provide feedback to the VoIP applications. The feedback on packet delay, jitter, and loss rate enables the applications to adapt to network conditions to maintain a certain level of voice quality. With this architecture, the quality of service of VoIP relies on the effectiveness of the RTCP network performance report mechanism.

This research collects RTCP performance reports from live traffic over real networks and compares their values with the statistics derived from direct measurements of RTP packets to evaluate the effectiveness of RTCP. The live experiments were conducted on networks resembling respectively, Local Area Network (LAN), Wide Area Network (WAN), campus network, and encrypted wireless LAN. Results from these

experiments show that RTCP is effective for low delay networks but RTCP performance reports can be inaccurate for networks with large, volatile delays

**KEYWORDS:** VoIP, Telephony, RTCP, MOS, Performance Evaluation

### **3D VISUALIZATION OF INVARIANT DISPLAY STRATEGY FOR HYPERSPECTRAL IMAGERY**

**Kang Suk Kim-Captain, Korean Army**

**B.S., Korea Military Academy, 1994**

**Master of Science in Applied Physics-December 2002**

**Master of Science in Computer Science-December 2002**

**Advisors: Richard C. Olsen, Department of Physics**

**Donald P. Brutzman, Department of Information Science**

Spectral imagery provides multi-dimensional data, which are difficult to display in standard three-color image formats. Tyo, et al. (2001) propose an invariant display strategy to address this problem. This approach is to mimic the dynamics of human perception. The dimensionality of the data are reduced by using a Principal Component (PC) transformation, and then displayed by making use of a Hue, Saturation, and Value (HSV) display transform.

This study addresses the PC transformation strategy, looks for a global eigenvector via 3D visualization of HSV color space information, and examines the suggested algorithm to provide the most intuitive display. The user interface created in this thesis is capable of computing the necessary implementation of the proposed strategy, viewing selected Region of Interest (ROI) in HSV color space model in 3D, and viewing the 2D resultant image. A demonstration application uses Java language including Java2D, Xj3D Player, Document Object Model (DOM) Application Program Interfaces (API), and Extensible 3D Language (X3D). The Java2D API enables the user to load imagery, process data, and render results in a two-dimensional (2D) view. Xj3D and DOM APIs are introduced to visualize Tyo's invariant display strategy in three-dimensional (3D) views and then to save results as X3D scenes. These techniques appear to be inherently valuable and can serve as the basis for further research.

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**KEYWORDS:** Hyperspectral Imagery, 3D Visualization, X3D, Java Xj3D Player

### **ALTERNATE HIGH SPEED NETWORK ACCESS FOR THE LAST MILE**

**Peng Joo Lee-Captain, Singapore Army**

**B.S., University of Bath, 1998**

**Master of Science in Computer Science-December 2002**

**Advisor: Bert Lundy, Department of Computer Science**

**Second Reader: Mike Tatom, USWEST**

Existing copper wire infrastructure no longer provides the required bandwidth for today's bandwidth-intensive Internet applications. Homes and businesses in the last mile require the same access speeds offered by fiber optic cables. It is however, economically unfeasible to bring fiber optic cable to each and every house and business in the last mile.

Free Space Optics and IEEE 802.11 are two technologies that offer high-speed capability and are potential last mile network access options. Free Space Optics uses lasers and IEEE 802.11 uses radio waves to send large amounts of data from one place to another. Both are wireless and use license-free frequency band for transmission. Both are quickly deployable, easily scalable and cheaper to install and upgrade compared to wired infrastructures. These characteristics support applications that require high bandwidth and a high degree of mobility, which are common in the military and civil networks.

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This thesis addresses the last mile problem and the current available access technologies which are unable to provide a high speed solution. Free Space Optics and IEEE 802.11 wireless technologies are explored and applied to a fictitious city for an economic analysis as possible high-speed network access methods.

**KEYWORDS:** Free Space Optics, IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, Wireless Networking, Radio Frequency, Network Infrastructure

### **A METHODOLOGY FOR THE DEVELOPMENT OF SECURE VERTICAL WEB PORTALS**

**Peter A. Wu-Lieutenant Commander, United States Navy**

**B.S., United States Naval Academy, 1991**

**Master of Science in Computer Science-December 2002**

**Advisor: Neil C. Rowe, Department of Computer Science**

**Second Reader: Xavier Maruyama, Department of Physics**

In this thesis, the development of vertical web portals (vortals) that fulfill targeted organizational mission needs is investigated. This specific type of portal provides narrow-scoped data, information and services while affording the user accessibility over a public network, such as the Internet. As part of the investigation, a methodology for architecting such portals with explicit consideration of security policy is presented. The methodology, along with some preliminary guidelines, is intended to serve as a first approximation of a framework for both the development of vertical portals and the definition of doctrine on the application of vortals. This methodology is illustrated with an application to a Navy ship.

**KEYWORDS:** Vertical Web Portal, Secure Vertical Web Portal, Security Architecture, Security Policy, Knowledge Management, Portal, Vortal, Methodology



# **MASTER OF SCIENCE IN CONTRACT MANAGEMENT**

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## **AN ANALYSIS OF COMMUNICATIONS BETWEEN THE UNITED STATES ARMY COMMUNICATIONS-ELECTRONICS COMMAND (CECOM) AND INDUSTRY**

**Linda College-DoD Civilian**

**B.S., Kean College of New Jersey, 1991**

**Master of Science in Contract Management-December 2002**

**Advisor: Jeffrey R. Cuskey, Graduate School of Business and Public Policy**

**Associate Advisor: Gary D. Notte, United States Army Communications-Electronics Command**

This research examines the methods of communications utilized between the U.S. Army's Communications-Electronics Command (CECOM), Fort Monmouth, New Jersey and its supplier base. The primary intent is to examine the effectiveness of various communication methods. As part of this discussion of communications, this thesis will discuss various methods utilized by the CECOM Acquisition Center to interface with industry, but will specifically address the effectiveness of three methods. These three methods consist of the Joint Partnering Contractor (JPC), Technical and Industry Liaison Office (TILO) and the U.S. Army Interagency Interactive Business Opportunities Page (IBOP). Finally, this thesis will analyze the effectiveness of the methods utilized by the CECOM Acquisition Center and make recommendations on how these methods can improve.

**KEYWORDS:** Communication, Technical Industrial Liaison Office, Joint Partnering Contractor, Interactive Business Opportunity Page

## **ACQUISITION REFORM THROUGH ALPHA CONTRACTING**

**Connie M. Goodwin-DoD Civilian**

**B.S., Athens State University, 1991**

**Master of Science in Contract Management-December 2002**

**Principal Advisor: James Suchan, Graduate School of Business and Public Policy**

**Associate Advisor: James Ganoe, U.S. Army Space and Missile Command**

The focus of acquisition reform is to obtain better products for the Department of Defense (DoD) and motivate the actual contracting process of acquiring those products for defense systems. The motivation comes from acquisition reform. The Alpha Contracting Process is one of several innovative contracting concepts of acquisition reform that has been implemented by several commands. The purpose of this thesis will be to determine the effectiveness of the Alpha Contracting Process. Data gathered from field research, interviews, case studies, and survey data are employed to support the effectiveness of Alpha Contracting. Advantages, disadvantages, and potential inhibitors to Alpha Contracting are discussed, as well as mechanisms to overcome the inhibitors. This thesis will provide a model of the traditional contracting process versus the alpha contracting process.

The thesis concludes that alpha contracting can innovate the contracting process and provides recommendations for future research.

**KEYWORDS:** Alpha Contracting, Process Innovation, Acquisition Reform Initiatives, Traditional Contracting, Sole Source Contracting, and Integrated Product Teams





# **MASTER OF SCIENCE IN DEFENSE ANALYSIS**

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## **EXPERIMENTAL ANALYSIS OF INTEGRATION OF TACTICAL UNMANNED AERIAL VEHICLES AND NAVAL SPECIAL WARFARE OPERATIONS FORCES**

**Joseph Clayton Butner, IV-Lieutenant, United States Navy  
B.S., Southern Illinois University, 1995**

**Master of Science in Defense Analysis-December 2002**

**Advisor: David W. Netzer, Dean of Research**

**Second Reader: Phil E. DePoy, Wayne E. Meyer Institute of Systems Engineering**

An experimental investigation was conducted to examine the use of small, expendable, endurance UAVs to enhance the combat effectiveness of Naval Special Warfare Forces (NSW). The experiment involved UAVs, NSW forces, and a red team in a downed-pilot rescue mission. Models were developed to determine optimum flight patterns for all UAVs. Models were also developed and utilized to determine experimental variables and measures of effectiveness. Simulation of the exercise was conducted to determine adequacy of the experiment plan.

It was found that UAVs significantly enhanced force protection, provided direct improvement in C2, significantly enhanced situational awareness, and provided the ability to track blue forces. It was found that video feed to blue force foot patrols may not be as valuable as having the C2 element dedicated to viewing the feed provide real-time COMS relay to the patrol. The exercises demonstrated that NSW forces do not need to launch and fly UAVs in order to utilize their capabilities; rather UAVs can be located and launched at the Forward Operating Base. The data obtained imply that small, expendable, endurance UAVs may do more than enhance capabilities for current missions, they may enable NSW Forces to conduct missions previously considered too high-risk.

**KEYWORDS:** Unmanned Aerial Vehicles, UAV, Naval Special Warfare, Special Operations, SEALs, CSAR



# **MASTER OF SCIENCE IN ELECTRICAL ENGINEERING**

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## **AN ELECTROMAGNETIC INTERFERENCE ANALYSIS OF UNINTERRUPTIBLE POWER SUPPLY SYSTEMS IN A DATA PROCESSING ENVIRONMENT**

**Edward W. Beran-DoD Civilian**

**B.S.E.E., University of Maryland, 1973**

**Master of Science in Electrical Engineering-December 2002**

**Advisor: Richard Adler, Department of Electrical and Computer Engineering**

**Second Reader: Wilbur R. Vincent, Department of Electrical and Computer Engineering**

**Donald P. Lyons, National Security Agency**

In this thesis, the levels of Electromagnetic Interference (EMI) generated by two standard models of Uninterruptible Power Supplies (UPS) are examined. EMI reduction actions were undertaken on both units. A significant reduction in the level of EMI was achieved using inexpensive, commercially available filters that were properly installed. The principles of proper installation are described. The reduction of EMI to harmless levels at radio-receiving and data-processing sites equipped with UPS is shown to be feasible.

**KEYWORDS:** Conducted Electromagnetic Interference, Spectrum Analyzer, Analog Filter, Power Line Filters, Uninterruptible Power Supply, UPS

## **HIGH ENERGY LASERS FOR SHIP-DEFENSE AND MARITIME PROPAGATION**

**Vasileios Bouras-Lieutenant, Hellenic Navy**

**B.S., Hellenic Naval Academy, 1993**

**Master of Science in Applied Physics-December 2002**

**Master of Science in Electrical Engineering-December 2002**

**Advisor: William B. Colson, Department of Physics**

**Co-Advisor: Phillip E. Pace, Department of Electrical and Computer Engineering**

High Energy Lasers (HELs) are a new class of weapons that may be of great value to the Navy in the near future. A high-power Free Electron Laser (FEL) is being designed using short Rayleigh-length resonators to increase the spot size at the mirrors and hence avoid mirror damage. Three-dimensional simulations are used to study the effects of an electron beam misalignment (electron beam tilt). This thesis shows that the proposed design is tolerant of typical electron beam misalignments. The performance of a step-tapered undulator is also studied for the 100 kW proposed upgrade of the Jefferson Laboratory FEL. The results of this research show that the gain is above the required threshold for the 100 kW design while the energy spread does not change significantly over any undulator design. The spectrum of the proposed FEL shows that most of the power is concentrated around the fundamental frequency. It is shown in this thesis that smooth FEL pulses can significantly reduce the negative effects of absorption and scattering. Recent HEL science and technology developments are discussed for both Free Electron and Solid-State Lasers.

**KEYWORDS:** Free Electron Laser, Solid-state Lasers, High Energy Lasers, Short Rayleigh Length, Step-taper Undulator, SSHCL, Laser Propagation

# **ELECTRICAL ENGINEERING**

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## **DESIGN OF A MICROSTRIP PATCH ANTENNA FOR THE NPSAT1**

**Mahmut Erel-Lieutenant Junior Grade, Turkish Navy**

**B.S., Turkish Naval Academy, 1996**

**Master of Science in Electrical Engineering-December 2002**

**Advisor: Jovan E. Lebaric, Department of Electrical and Computer Engineering**

**Second Reader: Richard Adler, Department of Electrical and Computer Engineering**

This thesis presents the design of two circularly polarized patch antennas to operate at 1.767 GHz and at 2.207 GHz (for receiving and transmitting, respectively). Additional design requirements for the antennas of NPSat1 satellite include a SWR of less than or equal to 2:1 and 50 $\Omega$  input impedance. The study will also include that the development of a three-dimensional antenna model that will be installed on the NPSat1. Also included is the simulation the application of RF energy into the antenna model and analysis of results, based on various outputs of the CST Microwave Studio Finite Difference Time Domain (FDTD) software package.

**KEYWORDS:** Microstrip Patch Antenna, NPSat1, Narrow-band, Low Power Satellite Antennas, Elliptical Patch, FDTD Electromagnetic Modeling, Patch Antenna Simulation

## **FREE ELECTRON AND SOLID STATE LASERS DEVELOPMENT FOR NAVAL DIRECTED ENERGY**

**Aristeidis Kalfoutzos-Lieutenant, Hellenic Navy**

**B.S., Hellenic Naval Academy, 1993**

**Master of Science in Applied Physics-December 2002**

**Master of Science in Electrical Engineering-December 2002**

**Advisor: William B. Colson, Department of Physics**

**Second Reader: Phillip E. Pace, Department of Electrical and Computer Engineering**

A MW level FEL is being designed with a short a Rayleigh length resonator to increase the spot size at the mirrors and to avoid mirror damage. In this thesis, it is found that it is desirable to focus the electron beam to improve the FEL extraction efficiency. Three-dimensional simulations show that the focused electron beam increases the extraction efficiency far beyond the required value of 0.7%. It is also found in this thesis that shifting the electron beam off-axis less than 0.3 mm, the efficiency remains above the required value. The proposed FEL design uses high power, short optical pulses whose spectrum may cover many absorption lines. The absorbed laser energy can heat up the air resulting in defocusing the laser beam (thermal blooming). This thesis shows that thermal blooming is not an issue for a moderate clear atmosphere when the stagnation zone size remains less than 10 m. A transitional step for the development of a MW level FEL weapon is the proposed 100 kW upgrade of the Thomas Jefferson National Accelerator Facility's FEL. It has also been shown in this thesis that the use of a step-taper undulator slightly improves the performance of the FEL. Finally, the potential of various high average power solid-state laser designs are reviewed.

**KEYWORDS:** Free Electron Laser, Propagation of High Power Free Electron Laser Pulses, Thermal Blooming, Focused Electron and Optical Beams, Desynchronization, Step-taper Undulator, High Power Solid-state Laser

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## ELECTRICAL ENGINEERING

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### PERFORMANCE OF *IEEE 802.11a* WIRELESS LAN STANDARD OVER FREQUENCY-SELECTIVE, SLOWLY FADING NAKAGAMI CHANNELS IN A PULSED JAMMING ENVIRONMENT

Irfan Kosa-Lieutenant Junior Grade, Turkish Navy  
B.S., Turkish Naval Academy, 1997

Master of Science in Electrical Engineering-December 2002

Advisor: R. Clark Robertson, Department of Electrical and Computer Engineering

Second Reader: Tri T. Ha, Department of Electrical and Computer Engineering

Wireless local area networks (WLAN) are increasingly important in meeting the needs of the next generation broadband wireless communication systems for both commercial and military applications. In 1999, the *IEEE 802.11a* working group approved a standard for a 5-GHz band WLAN that supports a variable bit rate from 6 to 54 Mbps, and orthogonal frequency-division multiplexing (OFDM) was chosen because of its well-known ability to avoid multipath effects while achieving high data rates by combining a high order sub-carrier modulation with a high rate convolutional code. This thesis investigates the performance of the OFDM based *IEEE.802.11a* WLAN standard in frequency-selective, slowly fading Nakagami channels in a pulsed-noise jamming environment. The benefit of such an analysis is to assess the performance of an existing OFDM standard and to gain some insight into how well these systems will perform in military applications when subjected to hostile jamming. Contrary to expectations, the signal-to-interference ratio (SIR) required to achieve a specific  $P_b$  does not monotonically decrease when the bit rate decreases. Furthermore, the results show that the performance is improved significantly by adding *convolutional coding* with *Viterbi decoding*, and thus highlights the importance of forward error correction (FEC) coding to the performance of wireless communications systems.

**KEYWORDS:** *IEEE 802.11a* Standard, WLAN, OFDM, BPSK, QPSK, QAM, Probability of Bit Error, Frequency-selective Fading, Fast Fading, Slow Fading, Nakagami Fading, Viterbi Algorithm, Convolutional Code, Hard Decision Decoding, Soft Decision Decoding, Coding Gain, Pulsed Jamming

### FACE RECOGNITION USING INFRARED IMAGING

Diogo C. Pereira-First Lieutenant, Brazilian Air Force  
B.S.E.E., Instituto Tecnológico de Aeronautica, Brazil, 1994  
Electrical Engineer-December 2002

Master of Science in Electrical Engineering-December 2002

Thesis Supervisor: Monique P. Fargues, Department of Electrical and Computer Engineering

Thesis Co-Supervisor: Gamani Karunasiri, Department of Physics

Thesis Committee Member: Roberto Cristi, Department of Electrical and Computer Engineering

This study investigated an infrared (IR) face recognition system using an uncooled IR camera. A computer-based image collection set-up was designed and used to create a small database of 420 facial images, from 14 volunteers. Manual and automated facial image cropping routines were implemented. Two linear approaches for the dataset dimension reduction and classification were implemented and their resulting classification performances compared: PCA-based and LDA approaches. Results show that the best PCA-based average classification performance is equal to 92.22% while the LDA-based classification performance is equal to 99.40%. These results successfully show that an uncooled IR camera may be used to discriminate between individual subjects obtained from a small database collected under a very controlled environment.

**KEYWORDS:** Face Recognition, Classification, PCA, LDA, IR, Infrared, Eigenvectors

# **ELECTRICAL ENGINEERING**

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## **PERFORMANCE EVALUATION OF A COOPERATIVE DIVERSITY ENHANCED AD HOC NETWORK**

**Michael A. Tope-DoD Civilian**

**B.S.E.E., University of Akron, 1984**

**Master of Science in Electrical Engineering-December 2002**

**Advisor: John McEachen, Department of Electrical and Computer Engineering**

**Second Reader: R. Clark Robertson, Department of Electrical and Computer Engineering**

Currently, wireless multi-hop ad hoc networks utilize protocols that relay packets of data node-by-node along a path connecting the source node to the sink node. This thesis describes a new methodology called "Cooperative Diversity" where information is relayed from the source to the sink via clusters of neighboring nodes. First, a routing protocol to establish spatially diversified paths through a field of randomly dispersed nodes is described. Second, an idealized configuration called the "Synthetic Waveguide" is introduced and its information theoretic channel capacity is developed. Third, an outage model based channel capacity for the synthetic waveguide operating with a low forwarding latency is derived. The low latency channel capacity is far different from that predicted by traditional channel capacity. Next, a simple modulation called stuttered simulcast is introduced and shown to approach the performance of an optimal distributed space-time code. Finally, a Monte Carlo simulation of the cooperative diversity routing protocol confirms its superior performance in regions of operational interest.

**KEYWORDS:** Wireless, Ad Hoc Network, Synthetic Waveguide, Cooperative Diversity, MIMO, Channel Capacity, Outage Model

## **NARROWBAND FILTERING EFFECTS ON FREQUENCY-HOPPED SIGNALS**

**Kevin A. Waters-DoD Civilian**

**B.S.E.E., Clemson University, 1996**

**Master of Science in Electrical Engineering-December 2002**

**Advisors: R. Clark Robertson, Department of Electrical and Computer Engineering**

**Kyle E. Kowalske, National Security Agency**

**Second Reader: Tri T. Ha, Department of Electrical and Computer Engineering**

A low complexity solution to remove follower, narrowband tone jamming signals which are randomly dispersed within the bandwidth of a hop without causing non-linear phase distortions in a frequency-hopping (FH) system is explored. Forward and reverse processed narrow stopband, elliptical infinite impulse response (IIR) filters are designed and applied to known audio and digital data. Analysis focuses on narrowband filtering one hop of a FH signal in the absence of noise. The results are compared with the output of equivalent finite impulse response (FIR) filters and equivalent forward processed IIR filters. This analysis demonstrates the effectiveness of forward and reverse narrow bandstop IIR filtering to eliminate unwanted tone jamming signals while preserving the phase of the received FH signal. These results also suggest that a FH system with narrow bandstop filtering can operate reliably in the presence of a high power tone jamming signal.

**KEYWORDS:** Frequency-hopping, Narrowband Tone Jamming, FIR, IIR, Non-linear Phase Distortion

# **MASTER OF SCIENCE IN ENGINEERING ACOUSTICS**

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## **THE INFLUENCE OF SHALLOW WATER VARIABILITY ON SHORT RANGE WATER BOURNE PROPAGATION**

**Stephen C. Karpi-Lieutenant, United States Navy**

**B.S., University of Arizona, 1995**

**Master of Science in Engineering Acoustics-December 2002**

**Advisor: Kevin B. Smith, Department of Physics**

**Co-Advisor: Peter H. Dahl, Applied Physics Laboratory, University of Washington**

Interest in enhancing the forecasting capabilities of both active and passive sonar systems employed in littoral regions has greatly escalated over the past 10 years. This requires a need for improvements in the general understanding of the influence of shallow water variability on acoustic propagation. This work examines the influence on the relatively short-range water-borne propagation paths of shallow water variability. Both internal wave fluctuations and random sound speed perturbations will be considered. The effects of littoral variability on acoustic propagation will be quantified in terms of spatial (vertical) coherence functions. Since the effects of the water-column variability is of interest, the direct water-borne propagation path will be solely analyzed. The data to be examined will be generated numerically based on an acoustic propagation model employing environmental data taken from the East China Sea as part of the ONR-sponsored ASIAEX experiments.

**KEYWORDS:** Shallow Water Variability, Range Independent, Range Dependence, Internal Wave Perturbations, Random Perturbations, Vertical Coherence





# **MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT**

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## **MEASURING THE VALUE OF GRADUATE INFORMATION TECHNOLOGY EDUCATION FOR MARINE OFFICERS: A PROOF OF CONCEPT STUDY**

**Terry L. Branstetter-Major, United States Marine Corps**

**B.S., Georgia Institute of Technology, 1991**

**Master of Science in Information Technology Management-December 2002**

**Advisor: Thomas Housel, Department of Information Science**

**Associate Advisor: Glenn Cook, Department of Information Science**

This research examines a process to estimate the value of graduate education. Moreover, it demonstrates an approach to measuring the use of graduate education within organizations. Marine Corps officers who graduated from the Naval Postgraduate School's Information System Technology curriculum are studied. The study used a web-based survey for data collection and a Knowledge Value Added method to objectively estimate the value of education topics across different Marine Corps processes. Results indicate that the Information System Technology curriculum is designed and implemented to successfully meet sponsor requirements. It reveals that the education is highly valued and frequently used in post graduation billets. The most valued aspect of the education is theoretical knowledge. However, the research showed how practical information technology skills and social relationships that developed during the resident education were also highly valued and frequently used. The results go on to show that personal interest in education topics often corresponded to greater perceived value. Lastly, a proof of concept demonstrates a method to measure and compare the use on graduate education in subsequent organizational processes. The Knowledge Value Added method provides the ability to compare education use between different topics, across different jobs, and between different people.

**KEYWORDS:** Education, Graduate Education, Information System Technology, IST, Information Technology Management, ITM, Knowledge Value Added, KVA, Naval Postgraduate School, NPS, Marine Corps, USMC



# **MASTER OF SCIENCE IN MANAGEMENT**

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## **ALTERNATIVE HEADQUARTERS SUPPORT FUNDING FOR THEATER SPECIAL OPERATIONS COMMANDS**

**Wayne W. Anderson, Jr.-Lieutenant Commander, United States Navy  
B.S., United States Naval Academy, 1992**

**Master of Science in Management-December 2002**

**Advisor: Lawrence R. Jones, Graduate School of Business and Public Policy**

**Associate Advisor: Jerry L. McCaffery, Graduate School of Business and Public Policy**

The current funding mechanism for theater special operations command (SOC) headquarters support costs is inadequately supported by legal guidance. Existing legislation and policy documents do not formalize theater SOC funding relationships to provide an enforcement tool that ensures the theater SOC headquarters support requirements. Consequently, the ambiguity of this funding mechanism has allowed the theater SOC headquarters support requirements to develop unique scenarios for financing headquarters support. To remedy this deficiency, this thesis conducts a comparative analysis of current theater SOC headquarters support funding mechanisms and examines three funding alternatives. This thesis concludes the best alternative would mandate that the Services assign separate Program Element (PE) numbers to theater SOC headquarters support in the Future Years Defense Program (FYDP) and distribute theater SOC headquarters support funding through the respective theater combatant commands. In addition, the thesis generates criteria that may be used in preliminary analysis by other commands that face similar funding ambiguities and may need to identify alternative funding mechanisms.

**KEYWORDS:** Theater Special Operations Command, SOC, Headquarters Support Costs, Resource Allocation, Budget Execution

## **MODELING SHIP AIR CONDITIONING MAINTENANCE COSTS USING THE INTEGRATED CONDITION ASSESSMENT SYSTEM**

**Gregory D. Blyden-Lieutenant, United States Navy  
B.S., University of Houston, 1995**

**Master of Science in Management-December 2002**

**Advisor: William J. Haga, Graduate School of Business and Public Policy**

**Associate Advisor: John E. Muttu, Graduate School of Business and Public Policy**

The United States Navy operates in seas such as the Arabian Gulf, where water temperatures can exceed 90 degrees and air temperatures surpass 95 degrees. An intuitive link exists between these higher operating temperatures and an increased demand on shipboard Air Conditioning (A/C) plants. Increased plant usage, in turn, causes higher A/C plant maintenance costs. To build an accurate cost model for shipboard Air Conditioning plants, this thesis examines the relationship between seawater temperature, A/C plant run-hours, and A/C plant maintenance costs. Data generated by the Integrated Condition Assessment System (ICAS) were used to test a correlation between these factors for TICONDEROGA, ARLEIGH BURKE, and OLIVER HAZARD PERRY class ships. The results indicate that although seawater temperature is a statistically significant factor in determining A/C plant use, plant use is not a statistically significant driver of maintenance costs. Although the findings discourage further research into this area, the methodology developed for using ICAS data may be applied to other shipboard systems.

**KEYWORDS:** Air Conditioning Plants, Maintenance Costs, Integrated Condition Assessment System, Pearson Correlation, Seawater Temperature, Analysis of Variance

## **MANAGEMENT**

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### **AN ANALYSIS OF FEDERAL HEAD CONTRACTING AUTHORITY (HCA) DECISIONS REGARDING OVERRIDES OF STATUTORY STAYS OF CONTRACT AWARD AND CONTINUED PERFORMANCE RESULTING FROM BID PROTESTS**

**Robert A. Brooks, Jr.-Lieutenant Commander, United States Navy  
B.S., University of Florida, 1990**

**Master of Science in Management-December 2002**

**Advisor: Ron Tudor, Graduate School of Business and Public Policy**

**Second Reader: LTC Rodney E. Tudor, USA, Graduate School of Business and Public Policy**

This research examines the Federal agency source selection process within Federal contracting agencies by conducting an analysis of Federal Head Contract Authority (HCA) decisions to override the required statutory stay of contract award and performance, in accordance with the Competition in Contracting Act (CICA) of 1984, resulting from bid protests. This thesis includes an analysis of the Government Accounting Office (GAO) Comptroller General of the United States findings and independent research data with respect to Federal agency decisions concerning suspension of contract award and continued performance resulting from pre-award and post-award bid protests. This research evaluates the effectiveness of the Federal agency source selection process via an analysis of HCA and GAO decisions concerning suspensions of contract awards as a result of pre-award bid protests within the previous seven fiscal years. This research also evaluates HCA and GAO justifications for continued contract performance despite post-award bid protests within the previous seven fiscal years. The objectives are to determine if Federal contracting agency decisions are justified because of the source selection process being executed as designed, and to determine if agency judgments to continue performance are supporting the best needs of the Government. Although the study contained discrepancies between GAO and independent research metrics, the overall data collection and analysis led to a general conclusion that HCA overrides are justified and that the Federal source selection process is functioning as designed. Furthermore, the research led to a general conclusion that protests sustained by the GAO occurred as a result of HCA noncompliance with stated acquisition administrative procedures.

**KEYWORDS:** CICA 1984, Bid Protests, HCA Override, Stay of Award, Stay of Continued Performance, Source Selection, GAO Protest Decisions, Contract Law

### **ANALYZING CURRENT MULTIPLE-AWARD TASK ORDER CONTRACTING PRACTICES AND ITS IMPACT ON COMPETITION, PRICING AND SOCIO-ECONOMIC GOALS**

**Joseph L. Burroughs, II-Major, United States Marine Corps  
B.S., Savannah State College, 1989**

**Master of Science in Management-December 2002**

**Advisor: Ron Tudor, Graduate School of Business and Public Policy**

**Co-Advisor: David R. Henderson, Graduate School of Business and Public Policy**

Present procurement practices for commercial, commercial-off-the-shelf, and non-developmental products and services take thirty days and sometimes years to procure and deliver to the end user. Federal Government contracting offices spend costly amounts of time advertising the action and preparing formal solicitation documents for each purchase order generated by the end-user. This translates to high administrative cost, high prices and, at times, marginal performance. This research offers alternative procurement practices through a single award indefinite delivery indefinite quantity contract accessed through an advanced electronic system, which is maintained by an in accordance with commercial established practices. Further comparisons are made with the growing popularity of multiple-award contracts as these procurement instruments affect competition, pricing and socio-economic issues.

**KEYWORDS:** Competition, Pricing, Socio-economic Issues, Single Award Indefinite Delivery and Indefinite Quantity Contract, Multiple-Award Task Order Contract, Advanced Electronic System

# MANAGEMENT

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## **AN ANALYSIS OF THE TAIL TO TOOTH RATIO AS A MEASURE OF OPERATIONAL READINESS AND MILITARY EXPENDITURE EFFICIENCY**

**Tamara L. Campbell-Captain, United States Marines Corps**

**B.S., United States Naval Academy, 1997**

**Master of Science in Management-March 2003**

**Carlos H. Velasco-Captain, Colombian Navy**

**B.S., Colombian Naval Academy, 1980**

**M.S., Naval Postgraduate School, 1992**

**Master of Science in Management-December 2002**

**Thesis Advisor: John E. Mutty, Graduate School of Business and Public Policy**

**Associate Advisor: William R. Gates, Graduate School of Business and Public Policy**

The Tail-to-Tooth Ratio (TTR) expresses the relationship between the resources or forces employed to perform the core missions and the resources or infrastructure used to manage and support those forces. Several methods are used in DoD to measure the TTR, all of which attempt to establish an unambiguous boundary between "tail" and "tooth." Specific cases and examples confirm that such a clear-cut limit does not exist. On the contrary, the definitions of "tail" and "tooth" change with the specific situation, the environment and the timing of the measurement.

The lack of a clear boundary suggests that the relationship between "tail" and "tooth" should not continue to be expressed as a ratio or a mathematical relationship between two numbers, but as a continuum. The "Tail-to-Tooth Continuum" can be represented in more than one dimension in relation to the number of variables used to characterize the position of a specific activity on the continuum.

This new approach focuses on outputs and outcomes and could prevent the unnecessary labeling of costs, allowing management to concentrate on increasing efficiency and reducing the total costs of attaining DoD's desired outcomes.

**KEYWORDS:** Tail-to-Tooth Ratio, DoD Force Structure, DoD Infrastructure, Tail-to-Tooth Continuum, DoD Tail, DoD Tooth

## **AN ANALYSIS OF THE GOVERNMENT COMMERCIAL PURCHASE CARD WITHIN THE UNITED STATES MARINE CORPS**

**George T. Carroll-Captain, United States Marine Corps**

**B.S., Tarleton State University, 1995**

**Master of Science Management-December 2002**

**Advisor: Marshall Engelbeck, Graduate School of Business and Public Policy**

**Second Reader: David V. Lamm, Graduate School of Business and Public Policy**

In this thesis, two lossless compression approaches are presented. The Rotational Tree Approach (RTA) is based upon mathematics developed by Fredricksen. RTA uses the rotations associated with binary necklace classes to disperse source bit strings to a forest of Huffman encoding trees. The Indexed Tree Approach (ITA) also uses a Huffman forest, but disperses bit strings via a simpler mechanism based upon the first few bits of each string. For text compression, the RTA is found to be competitive with standard Huffman encoding while ITA is generally superior by a small margin of one to three percent. Both approaches owe their (limited) success to decreased modeling overhead as compared to standard Huffman encoding. Compression results against the Canterbury Corpus test suit and complete Java implementation code are included as appendices.

**KEYWORDS:** Government-wide Commercial Purchase Card, Acquisition

# **MANAGEMENT**

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## **ANALYSIS OF THE DEPARTMENT OF DEFENSE HOMELAND SECURITY SUPPORT ORGANIZATION**

**Michael P. Cavil-Lieutenant Commander, United States Navy Reserve  
B.B.A., University of Texas, 1990**

**Master of Science in Management-December 2002**

**Thesis Advisor: Joseph G. San Miguel, Graduate School of Business and Public Policy**

**Associate Advisor: Donald E. Summers, Graduate School of Business and Public Policy**

Implementing U.S. Homeland Security Strategy is probably the most difficult challenge facing the U.S. today. As a result of the Strategy, it is envisioned that many federal, state, local and private organizations will need to develop internal organizations for coordinating support with the Department of Homeland Security. The organization that could potentially have the greatest impact on U.S. Homeland Security Strategy achievement is the Department of Defense. Therefore, it is critical that the Department of Defense design an effective internal organization for supporting the U.S. Homeland Security Strategy and the Department of Homeland Security. This thesis will analyze the Department of Defense's initial efforts in developing its Homeland Security Support organization, and will evaluate its potential effectiveness for supporting the U.S. Homeland Security Strategy. This thesis further seeks to provide a model for organizations to utilize in developing and diagnosing their homeland security support organizations.

**KEYWORDS:** Department of Defense Homeland Security Support Organization, Department of Defense Homeland Security Support, Department of Homeland Security, U.S. Homeland Security, Homeland Security Support Organizations, Transformation, Organizational Systems, Cybernetic Feedback Model

## **SEA JAVELIN: AN ANALYSIS OF NAVAL FORCE PROTECTION ALTERNATIVES**

**Daniel Cobian-Lieutenant, United States Navy**

**B.A., University of San Diego, 1997**

**Master of Science in Management-December 2002**

**Advisor: John T. Dillard, Graduate School of Business and Public Policy**

**Second Reader: Mary Malina, Graduate School of Business and Public Policy**

The U.S. Navy continues to provide a forward presence, conduct freedom of navigation operations and deploy throughout the world. There exists a very real threat to the vessels and crew of the U.S. Navy; terrorists have proven they are willing and able to use low-cost, high-impact weapons. The Navy needs weapons that are mobile, cost-efficient, easily integrated into the fleet and, most importantly, these weapons are needed immediately. This need, combined with current budgetary considerations, compels us to seek weapons that are ready to be employed into the fleet today. The traditional evolutionary process will not provide a capable weapon in a timely or cost-effective manner. The need and the weapon exist today. That weapon is the Army M98A1 Javelin Anti-Armor Missile.

The goal of this thesis is to: (1) Examine the need for a stand-alone, point-defense weapon to effectively combat the small boat threat while underway in restricted waters as well as in port; (2) Discuss shortfalls of current weapons systems used in the fleet to combat this threat; (3) Identify the suitability of the Javelin to meet that threat; (4) Discuss the potential cost avoidance available to the DoD if such an endeavor was to take place.

**KEYWORDS:** Suicide Boat, Swarm Tactics, Small Boat Attack, Ship Self Defense, Javelin Missile, Point Defense

# MANAGEMENT

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## THE PERFORMANCE OF REDUCTION OF TOTAL OWNERSHIP COST (R-TOC) PILOT PROGRAMS

Huseyin Demir-First Lieutenant, Turkish Army

B.S., Turkish Military Academy, 1997

Master of Science in Management-December 2002

Advisor: Michael W. Boudreau, Graduate School of Business and Public Policy

Second Reader: William R. Gates, Graduate School of Business and Public Policy

In April 1998, within the initiation of Section 912c studies (PM Oversight of Life Cycle Support), DoD expanded the responsibilities of Program Managers for designing and producing new weapon systems to include more accountability for the TOC of the systems, including O&S (Operation and Support) costs. At a December 1998 DSAC (Defense Systems Affordability Council), each service agreed to provide 10 program names for the 912c study. DoD would continue to track all 30 service pilot programs as R-TOC programs. This thesis analyzes the utilization of Reduction of Total Ownership Costs (R-TOC) pilot programs in DoD Services. It identifies the lessons learned from the R-TOC pilot programs and the obstacles encountered to promote efficient reductions in the Total Ownership Costs of DoD weapon systems. It also makes recommendations for DoD leadership to establish a more efficient R-TOC environment. The conclusion is that the performance of R-TOC is efficient because it forces PMs to consider TOC in their programs, and helps to identify obstacles, and encourages saving initiatives. Although further progress will be captured by blocking the inhibitors identified in Chapter IV, OSD should continue advocating R-TOC.

**KEYWORDS:** Total Ownership Cost, Operation and Support Cost, Cost Savings, Contractor Logistic Support, Total System Performance Responsibility, Reliability

## AN ANALYSIS OF THE BUDGET FORMULATION AND EXECUTION PROCESS IN UNITED STATES NAVAL DENTAL CENTERS AND PERFORMANCE MEASURE UTILIZATION IN THE PROCESS

Roberto F. Ecarma-Lieutenant, United States Navy

B.S., Ateneo de Manila University, 1986

M.H.A., Chapman University, 1996

Master of Science in Management-December 2002

Scott F. Hall-Lieutenant, United States Navy

B.A., Brigham Young University, 1996

M.S., Indiana University, 1999

Master of Science in Management-December 2002

Advisor: Jerry L. McCaffery, Graduate School of Business and Public Policy

Associate Advisor: John E. Muttu, Graduate School of Business and Public Policy

The purpose of this research is to examine the Planning, Programming, and Budgeting process within the Naval Dental Centers (NDCs) as well as their particular budget formulation and execution procedures. Since there is no extensive work concerning budgeting and Naval Dental Centers, this thesis stands as a small-scale representative of budgetary processes in this small but vital section of the military. Moreover, the lack of dental readiness among personnel of operational commands recently debated in Congress this summer illustrates the critical nature of this topic. To analyze the topic in depth, the following points, among others, concerning budgetary policies of Naval Dental Centers must be examined; how do NDCs fit in the overall budgeting process of the Navy, how NDCs formulate and execute budgets, what are the core missions and which ones are nearly always funded, how do marks and reclaims affect the process, what factors affect the disparity between the funding NDCs request for and what they actually receive, what performance measures are compiled and what role do they play in the budgeting process. The specific goal of this study is to provide prospective NDC comptrollers with the insight into procedures, technicalities, and peculiarities of a Medical Service Corps comptroller's job in a Naval Dental Center command.

**KEYWORDS:** Resources, Budget Formulation, Budget Execution, Strategic Planning, Performance Measures



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### **APPLYING DEPARTMENT OF DEFENSE FINANCIAL STATEMENT GUIDELINES TO THE NAVAL POSTGRADUATE SCHOOL**

**Robert E. Flannery, II-Captain, United States Marine Corps  
B.S., United States Naval Academy, 1998**

**Master of Science in Management-December 2002**

**Advisors: Donald E. Summers, Graduate School of Business and Public Policy  
Doug Moses, Graduate School of Business and Public Policy**

The federal government has focused on better business practices by implementing legislature, such as the Chief Financial Officer's Act of 1990, to initiate requirements for federal agencies to produce auditable financial statements. This thesis reviews the extent to which the Naval Postgraduate School can apply the guidelines for federal financial accounting to its own financial management capabilities. The financial information system capabilities and limitations are explained, showing how NPS accounts for the financial transactions during its operations and how these transactions are captured by the Department of the Navy's primary accounting system. This thesis also evaluates the capabilities of the Standard Accounting and Reporting System (STARS), as it pertains to NPS, and how its reports can be used to create the necessary financial statements described in the financial management regulations for the federal government.

**KEYWORDS:** Chief Financial Officer's Act, Department of Defense, Department of the Navy, Federal Accounting Standards Advisory Board, Financial Reporting, Financial Statements, NPS Financial Information Systems

### **AN ECONOMIC ANALYSIS OF ACQUISITION OPPORTUNITIES FOR THE UNITED STATES DEPARTMENT OF DEFENSE WITHIN THE JAPANESE DEFENSE INDUSTRIAL BASE**

**Eric B. Garretty-Major, United States Marine Corps  
B.A., University of Mississippi, 1990**

**Master of Science in Management-December 2002**

**Advisor: Raymond E. Franck, Graduate School of Business and Public Policy  
Associate Advisor: David F. Matthews, Graduate School of Business and Public Policy**

The Japanese Defense Agency (JDA) and the Japanese Defense Industrial Base (JDIB) are in a transitory period. A recession in the Japanese economy and an increasing requirement for participation by the Japanese military in regional and global venues has placed unprecedented demands on the JDA. The Department of Defense also finds itself in a transformational period where implementation of acquisition reform initiatives is an imperative. Given this environment, this thesis seeks to provide DoD Program Managers with a baseline economic analysis of the Japanese Defense Industry and identify potential synergies in U.S.-Japan acquisition efforts. An exposition of the Japanese Defense Industry's composition and status and a targeted comparison to the U.S. defense firms frames the current acquisition environment. Economic factors at work in U.S.-Japan acquisition efforts are identified through examination of past and current acquisition interfaces such as the FS-X co-development program and the Theater Missile Defense program. Specific and general acquisition opportunities are discussed and an assessment tool for evaluation of collaboration alternatives is proposed. This thesis finds that acquisition opportunities do exist for DoD within the JDIB and optimization of these opportunities can facilitate the DoD's effort to engage in "best-value" acquisition practices.

**KEYWORDS:** Japanese Defense Agency, Japanese Defense Industrial Base, Acquisition, Total Ownership Cost Reduction

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### **A CASE STUDY OF THE APPLICATION OF RELIABILITY CENTERED MAINTENANCE (RCM) IN THE ACQUISITION OF THE ADVANCED AMPHIBIOUS ASSAULT VEHICLE (AAAV)**

**Luis Garza-Captain, United States Marine Corps  
B.S., Hawaii Pacific University, 1997**

**Master of Science in Management-December 2002**

**Advisor: Michael W. Boudreau, Graduate School of Business and Public Policy**

**Associate Advisor: Ira A. Lewis, Graduate School of Business and Public Policy**

This thesis examined the application of Reliability Centered Maintenance (RCM) in the acquisition of the Marine Corps' Advanced Amphibious Assault Vehicle (AAAV). RCM is referred to throughout various service and DoD wide references, but in the absence of specific guidance on how to apply RCM to an acquisition, the AAAV program provided a unique opportunity to analyze key decisions and results. The research included an examination of the RCM process to include RCM training provided on site at the AAAV program, a review of pertinent program documents, interviews with program representatives, and an analysis of the critical decision to utilize the RCM process. The key findings of the research effort concluded that when RCM is applied to an acquisition with program commitment, the program will gain a greater, more focused understanding of the system and subsystems, than with the traditional Failure Modes and Effects Analysis (FMEA) and Failure Modes, Effects and Criticality Analysis (FMECA). AAAV also demonstrated that RCM benefits were broad and not limited to just maintenance analysis and that these benefits could be gained at any stage of the acquisition. This thesis concludes by recommending that the acquisition community recognize the benefits and institutionalize RCM into the acquisition process.

**KEYWORDS:** Marine Corps Advanced Amphibious Assault Vehicle Program, AAAV, Major Defense Acquisition Programs, Reliability Centered Maintenance

### **COST EFFECTIVENESS ANALYSIS OF THE "SEA TO SWOS" TRAINING INITIATIVE ON THE SURFACE WARFARE OFFICER QUALIFICATION PROCESS**

**Christopher C. Gavino-Lieutenant, United States Navy  
B.S., United States Naval Academy, 1997**

**Master of Science in Management-December 2002**

**Advisors: William R. Gates, Graduate School of Business and Public Policy**

**CDR William D. Hatch II, USN, Graduate School of Business and Public Policy**

The number of Surface Warfare Officers (111Xs) in a wardroom directly affects the combat readiness and effectiveness of a warship today. Preliminary research indicates that the "Sea to SWOS" training initiative is seen to have a positive effect on the amount of time it takes a 116X to attain the 111X designation. The initial qualitative analysis highlights a perceived increase in retention and readiness (combat effectiveness) while the quantitative analysis shows additional costs to the Navy Personnel Command and savings in training costs for the Naval Education and Training Command and OPNAV N76, the Surface Warfare Resource Sponsor.

This thesis examines the cost-effectiveness of the newly established "Sea to SWOS" training transformation on the Surface Warfare Officer qualification process. This initiative leverages shipboard on-the-job training experiences and interactive computer-based training replacing previously formalized classroom training. As a result, this initiative significantly alters the Division Officer Sequencing Plan (DOSP). Based on the qualitative data, the transformation to the DOSP in the Surface Warfare Officer qualification process will most likely have a positive effect on retention and the utilization of fully qualified 111X Division Officer resources through earlier numbers of 111X attainment and increased officer personnel readiness.

**KEYWORDS:** Cost Effectiveness Analysis of Surface Warfare Officer Training, Surface Warfare Training Costs, Streamlining Training, Retention, Surface Warfare Officer

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### **AN ANALYSIS OF THE FACTORS AFFECTING THE NET OPERATING RESULT AT NAVAL AVIATION DEPOT CHERRY POINT, NORTH CAROLINA**

**Scott M. Griffith-Major, United States Marine Corps**

**B.S., University of Wisconsin-Stevens Point, 1991**

**Master of Science in Management-December 2002**

**Advisors: Shu S. Liao, Graduate School of Business and Public Policy**

**John E. Muttty, Graduate School of Business and Public Policy**

This thesis explains the current process involved in establishing stabilized rates for the Naval Aviation Depot (NADEP) Cherry Point, North Carolina. Existing data were examined to aid in understanding the process for determining stabilized rates, workload standards, and workload allocation. Additionally, this research provides an analysis of the inputs to the rate setting process to determine which has the most influence on the financial operating result. A general history of working capital funds is provided and an explanation of the financial and management goals of the Navy Working Capital Fund are spelled out. An assessment of existing methods was based on variance analysis between projected results and actual results. The variance analysis suggests that the current methods used for determining workload standards consistently underestimate the number of hours required to complete the work. Finally a sensitivity analysis was conducted to determine which input variable has the most influence on the net operating result. The sensitivity analysis suggests that changes to workload norms have the most influence on the bottom line at the NADEP.

**KEYWORDS:** Navy Working Capital Fund, Naval Aviation Depot, Net Operating Result, Sensitivity Analysis, Variance Analysis, Stabilized Rate

### **ACQUISITION PLANNING FOR THE ARMED FORCES OF THE PHILIPPINES (AFP) MODERNIZATION PROGRAM**

**Antonio A. Habulan, Jr.-Commander, Philippine Navy**

**B.S., Philippine Military Academy, 1982**

**Master of Science in Management-December 2002**

**Advisor: Jeffrey R. Cuskey, Graduate School of Business and Public Policy**

**Associate Advisor: Ron Tudor, Graduate School of Business and Public Policy**

The purpose of this thesis is to determine the appropriateness and adequacy of the Armed Forces of the Philippines (AFP) acquisition planning practices to effectively meet the requirements of the AFP Modernization Program (AFPMP). The AFP Modernization Act of 1995 mandated the 15-year modernization of the AFP pursuant to Republic Act (RA) 7898. Consequently, the Department of National Defense (DND) issued Circular No. 1, also known as the Implementing Guidelines, Rules and Regulations (IGRR) to provide the policies and procedures for the AFPMP. Acquisition planning is key to the success of an acquisition because it provides the overall strategy for accomplishing and managing the acquisition. It is a formal documentation of the approach to satisfy the need of the warfighter, optimize resources, and fulfill the policy requirements of the proposed acquisition. In the AFP, planning for acquisitions depends on the Five-Year Rolling Plan, which contains the list of AFPMP projects and form the basis for the formulation of the Circular of Requirements (CORs). The circular does not elaborate on how to develop the CORs or the Bid Evaluation Plans (BEPs), a document similar to the source selection plan. This thesis evaluated AFP acquisition processes to determine the adequacy of AFP acquisition planning practices to adequately meet the needs of the AFPMP. However, the study found that acquisition plans are not even a requirement for the AFPMP projects and it is not mentioned in any of the other attendant documents to RA 7898 or to the IGRR. The study identified other issues that impact on acquisition planning for the AFPMP, which include lack of an acquisition organization, absence of a skilled acquisition workforce, no acquisition category designations for AFPMP projects, and lack of a single, coherent regulation that pertains to AFP weapon system acquisitions. The study then recommended acquisition plans to be a requirement for all AFPMP acquisitions and the adoption of the acquisition plan format in the FAR as a first step to the conduct of acquisition planning for AFPMP projects. With an acquisition plan that provides a logical and systematic approach for meeting the AFP need, the chance of success of AFPMP acquisition projects can be substantially improved.

**KEYWORDS:** Contract Administration, AFP Modernization Program

## **TWO-SIDED MATCHING FOR THE U.S. NAVY'S ENLISTED DETAILING PROCESS: A COMPARISON OF DEFERRED ACCEPTANCE VERSUS LINEAR PROGRAMMING VIA SIMULATION**

**Joshua H. Ho-Lieutenant Colonel, Republic of Singapore Navy**

**M.A., Cambridge University, 1993**

**Master of Science in Management-December 2002**

**Eng Hwee Low-Civilian, Ministry of Defence, Singapore**

**B.A., National University of Singapore, 1992**

**Master of Science in Management-December 2002**

**Advisor: William R. Gates, Graduate School of Business and Public Policy**

**Second Reader: CDR William D. Hatch, II, USN, Graduate School of Business and Public Policy**

Recent studies of two-sided matching mechanisms have suggested potential benefits for implementation into the Navy enlisted assignment process. The proposed matching process improves the chance of commands and sailors being assigned either a sailor or billet of their choice. The same studies focused on a particular two-sided Deferred Acceptance (DA) matching algorithm which ensures stable matches, prevents "off-the-site" trades between the matching parties and upholds integrity of the matching system. Although stable matches are important in a voluntary labor market, the DA algorithm may still favor one party depending on whether the command or sailor biased form of the algorithm is used.

The Linear Programming (LP) algorithm is an alternative that could optimize system (command and sailor) effectiveness and promote a balanced approach to meeting the preferences of both parties. Although LP does not guarantee stable matches, it is still employed by selective British hospitals for their matching with interns. The extent of the unstable matches has not been examined to measure it against the benefit of higher system effectiveness. This thesis will evaluate if the LP algorithm could serve as a better alternative to DA algorithm through simulation of the Navy enlisted assignment process.

**KEYWORDS:** Simulation Model, Distribution and Assignment, Two-Sided Matching, Detailing, Personnel Policy Analysis, Placement

## **NAVY FLYING CLUBS: MANAGEMENT, CONTROL SYSTEMS AND PERFORMANCE MEASURES**

**Aaron R. Knepel-Captain, United States Marine Corps**

**B.S., Iowa State University, 1997**

**Master of Science in Management-December 2002**

**Advisor: Kenneth J. Euske, Graduate School of Business and Public Policy**

**Second Reader: Jeffrey R. Cuskey, Graduate School of Business and Public Policy**

The Monterey Navy Flying Club has undergone tremendous change in the last decade. The club has sustained a painful downsizing due to the closure of Fort Ord and the substantial reduction in number of members, flight hours, aircraft, and staff. During the peak period when Fort Ord was open the volume of members and flight hours allowed informal short-term planning to fulfill all the clubs financial needs. Additionally, the club had an ample supply of surplus military aircraft (T-34Bs and T-41s) along with significant free parts support that allowed extremely low prices which covered all overhead.

Currently, the club has essentially depleted its supply of free parts support (especially engines and propellers) and is now faced with the dilemma of whether or not to keep one T-34B in compliance with an expensive Airworthiness Directive. Now more than ever, this club and other Navy Flying Clubs need objective strategic financial advice on what course of action to pursue.

The clubs current financial control measures do not provide insight into the financial health of the organization. MWR provides financial statements but there is currently no analysis of what the reports are saying. The focus has been on short-term thinking. When the clubs see they have enough money for the next month or two, they cease evaluating their financial position. This has led to clubs disbanding in the worst case and aircraft that are otherwise airworthy being grounded due to insufficient funds to overhaul

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and engine or other maintenance troubles. The club has been living in the short-term management mode for years and is still struggling to settle into its new business environment of fewer members and planes.

All Navy Flying Clubs need to start assessing their maintenance and aircraft replacement needs and budgeting accordingly. In the past, when free planes and parts were the norm the lack of planning had no effect. Today the same method is being used and clubs have no plans to pay for replacement aircraft when the current aircraft become unserviceable.

Monterey Navy Flying Club's focus has remained short term throughout this turbulent period. They have data to analyze, but no method to do so. What is needed is to determine what financial measures can be used to provide an assessment of how the club is performing in the short, medium, and long run.

**KEYWORDS:** Management Control Systems, Performance Measures, DOD

### **TEN YEARS WORTH OF DOD PROCUREMENT REFORMS WITH SPECIFIC ATTENTION TO SELECTED DON PROGRAMS**

**Bernard D. Knox-Lieutenant Commander, United States Navy**

**B.A., University of Florida, 1991**

**Master of Science in Management-December 2002**

**Advisor: Jerry L. McCaffery, Graduate School of Business and Public Policy**

**Associate Advisor: John E. Muttu, Graduate School of Business and Public Policy**

DOD reduced force structure after the Cold War ended. More efficient and sophisticated weapons are necessary to support a smaller force. Acquisition reform legislation is designed to capture savings and usher in a Revolution in Business Affairs. Today a wide array of rogue nations, transnational actors, and domestic terrorism demand weapons procurement reform that is effective against a smaller and much less visible foe. The Department of Defense's goal is to deliver modern, high performance weapons systems at lower cost, on schedule and with higher performance. Better weaponry drives the reality that the nation and the Department find themselves in an era of highly unpredictable security challenges. This research paper explores major procurement reforms and their effect on decreasing the amount of time and funds expended on current and future weapons systems. It looks for evidence of how the Department of the Navy's budget is impacted and what controls, if any, these reforms will have on future weapons procurement. The link between the Executive and legislative branches, DOD and program managers is examined to determine if procurement reform has helped.

**KEYWORDS:** Acquisition, Procurement Reform, MDAP, ACAT, Weapons, Budget

### **SOCIAL FACTORS IMPACTING RECRUITMENT AND RETENTION OF THE CIVILIAN ACQUISITION WORKFORCE**

**Neill G. Krost-DoD Civilian**

**B.A., Bowling Green State University, 1988**

**M.I.M., American Graduate School of International Management, 1990**

**Master of Science in Management-December 2002**

**Advisor: Raymond E. Franck, Graduate School of Business and Public Policy**

**Associate Advisor: CDR James Barnard, USN, Graduate School of Business and Public Policy**

This thesis looks at the recruitment and retention challenge facing the DoD's civilian acquisition workforce in light of the demographic gap caused by years of downsizing. It provides a qualitative assessment of the adequacy of existing recruitment and retention tools in light of the generational differences between current policymakers (Baby Boomers) and needed younger employees (Generation-X). Key generational characteristics are compared and assessed in relation to workforce recruitment and retention tools. The research indicates that although a generation gap exists it is not so large that bridges cannot be built. Personnel tools can be modified or created to enable culture change so that Generation-X values are embraced in the workplace. Of the existing tools, flextime, lateral movement and education opportunities, and the demo project appear most promising since they offer individual flexibility and empowerment. Among other things, this thesis recommends to increase internships; advertise career broadening and lateral

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movement opportunities; and centralize all job opportunities to a single site open to all interested applicants. These adjustments will help the DoD address its recruitment and retention goals.

**KEYWORDS:** Recruitment, Retention, Civilian, Acquisition Workforce, Generation-X, Baby Boomer, Demographic

### **PRIORITIZATION OF CAPITAL PROJECTS**

**Michael S. LaVielle-Lieutenant, United States Navy  
B.S., Seattle University, 1998**

**Master of Science in Management-December 2002**

**Advisors: William J. Haga, Graduate School of Business and Public Policy  
LTC Saverio M. Manago, USA, Department of Operations Research**

Public works capital projects in the U.S. Naval forces are not prioritized and funded in a way that best uses limited operations resources and maintenance dollars. This thesis develops a linear model for public works commands to effectively prioritize and fund capital projects. This model allows each command to set its own criteria and weightings which are then used to score and rank capital projects. Using objective criteria, it seamlessly integrates new projects with existing projects into a command's Integrated Project List. The time formerly needed to manually rank each new project against all other projects is saved. Moreover, a command is able to keep a complete and comprehensive list of all unfunded capital projects. The subjectivity inherent in manual project priority decisions is removed. Ways to use existing computer systems in public works commands through Annual Inspection Summary reports are explored. The project decision process was studied through interviews conducted in commands at varying levels of the public works hierarchy. The linear model for project prioritization was developed in Excel. A spreadsheet sample of the linear model and detailed step-by-step instructions for its construction are available upon request from the author. Suggestions are made for further development of the project prioritization process.

**KEYWORDS:** Public Works, Prioritization of Capital Projects, Annual Inspection Summary, Integrated Priority List, Linear Model

### **THE EVALUATION OF APPROPRIATENESS OF OMB CIRCULAR A-76 STUDIES ON REVENUE-GENERATING FUNCTIONS IN DEFENSE WORKING CAPITAL FUND ACTIVITIES**

**Thomas J. Moreau-Lieutenant Commander, United States Navy  
B.S., Union College, 1990**

**Master of Science in Management-December 2002**

**Advisor: CDR Philip J. Candreva, USN, Graduate School of Business and Public Policy  
Second Reader: Lawrence R. Jones, Graduate School of Business and Public Policy**

This thesis addresses the appropriateness of applying an OMB Circular A-76 study process on the revenue generating functions in Defense Working Capital Fund activities. While the thesis acknowledges that subjecting organizational functions to an A-76 process gains competitive efficiencies, the hypothesis is that a Working Capital Fund activity has already realized the efficiencies by competing for business; therefore, a process other than A-76 is more appropriate to gain further cost savings. The thesis looks at the specific example of the Navy Supply Information Systems Activity (NAVSISA), which is a Fee-for-Service organization that specializes in providing informational technology products and services for U.S. Navy, DoD and Foreign Allies.

**KEYWORDS:** Outsourcing, OMB Circular A-76 Studies, Defense Working Capital Fund, Fee-for-Service, NAVSISA



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### **AN ANALYSIS OF PERSONNEL CAREER DEVELOPMENT PRACTICES WITHIN THE UNITED STATES MARINE CORPS CONTINGENCY CONTRACTING FORCE**

**Joe H. Morris-Major, United States Marine Corps  
B.S., University of Florida, 1992**

**Master of Science in Management-December 2002**

**Advisor: Marshall Engelbeck, Graduate School of Business and Public Policy**

**Associate Advisor: David V. Lamm, Graduate School of Business and Public Policy**

Increased operational tempo, workforce reductions, and demanding legislation are creating a challenging environment for enlisted personnel serving in the contingency contracting force. Each branch of the U.S. military has responded differently to these challenges. The United States Marine Corps is heavily dependent upon enlisted personnel who are assigned the 3044 Military Occupational Specialty (MOS) to perform contingency contracting. This thesis explores the current environment, within which these contingency contracting Marines operate, and analyzes the affect this environment is having on their career development. The study begins with an examination of the historical development of contingency contracting, and reviews Government commissions that called for reform, which resulted in the establishment of the Defense Acquisition Workforce Improvement Act (DAWIA). The research then describes the requirements levied against contracting personnel under DAWIA and how they affect the enlisted military personnel. With this framework in place the study then evaluates the resulting approach to utilizing enlisted personnel for contingency contracting within the Military Services (Army, Navy, Air Force, Marines). This evaluation focuses on the organizational structure, education opportunities, training, career development, and employment of enlisted personnel within each of these Military Services and how this understanding can improve the career development of 3044s.

**KEYWORDS:** Contracting, Contingency Contracting, Career Development, USMC, Enlisted Personnel, DAWIA, Acquisition, Acquisition Workforce

### **AN ASSESSMENT OF THE IMEF DEPOT-LEVEL CORROSION PREVENTION AND CONTROL PROGRAM AND THE VIABILITY OF MAKING IT MORE EFFICIENT AND/OR OUTSOURCING THE REQUIREMENTS THROUGH PRIVATE SECTOR INITIATIVES**

**Steven J. Mullen-Major, United States Marine Corps  
B.S., University of Colorado-Boulder, 1984**

**Master of Science in Management-December 2002**

**Advisor: Ron Tudor, Graduate School of Business and Public Policy**

**Associate Advisor: Ken Doerr, Graduate School of Business and Public Policy**

In an era of both downsizing of Defense Budgets combined with high operational tempo, the military is faced with doing more with less as a way of life. Add to this the overall rise in the average age of the ground tactical and ground support equipment, and both preventative and corrective maintenance takes on added importance. Corrosion Prevention and Control is a necessity in extending the life of our equipment. This is especially true for the Marine Corps, which operates in harsh environments that quickly degrade its gear. While mandated programs at each echelon of maintenance are technically proficient, the Depot-level program, *to include transportation*, in use by IMEF appears to be inefficient. The objective of this thesis research was to analyze the present program used to meet the Depot-level requirements for the West coast and see if it gives the Corps the Best Value available. Best Value in this case considers both the effect on equipment readiness and overall cost. The present program to protect the assets is efficient and mostly cost effective, yet the transportation procedures are inefficient and not cost effective. This unnecessarily degrades readiness for the war fighter. It is proposed that implementing both the use of organic transportation assets and utilizing outsourcing will greatly improve Readiness levels to IMEF and lower overall program costs.

**KEYWORDS:** Corrosion, Preventative Maintenance, Fifth Echelon Maintenance, Corrosion Prevention and Control, C3 Program, Ground Tactical and Ground Support Equipment Maintenance, U.S. Marine Corps Ground Equipment Maintenance

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### **AN ANALYSIS OF THE REQUISITION PROCESS AND READINESS FOR F/A-18E/F INTEGRATED READINESS SUPPORT TEAM (FIRST) PROGRAM**

**Daniel J. Noll-Lieutenant Commander, Supply Corps, United States Navy  
B.S., Iowa State University, 1990**

**Master of Science in Management-December 2002**

**Bernard L. Simonson-Lieutenant, United States Navy**

**B.G.S., University of Idaho, 1995**

**Master of Science in Management-December 2002**

**Advisor: Don Eaton, Graduate School of Business and Public Policy**

**Associate Advisor: William R. Gates, Graduate School of Business and Public Policy**

Naval Aviation is beginning a transformation into a new era of logistics support. The beginning of a U.S. Navy/Industry teaming effort started with the U.S. Navy's F/A-18 E/F program. The new aircraft is supported through both standard military logistics programs and a brand new commercial logistics application known as F/A-18 E/F Integrated Readiness Support Teaming (FIRST). The non-traditional contract with Boeing is intended to outsource some of the maintenance, supply and inventory control for the new aircraft onto Boeing. The intended benefits behind the new concept include reduced costs, increased supply responsiveness and greater efficiency through commercial logistics applications. Promising increased aircraft readiness and seamless implementation, both Boeing and U.S. Navy representatives have great expectations for the new system.

This research investigates the impact FIRST is having on F/A-18 E/F Operational Availability (Ao) through an evaluation of Supply Response Times (SRT) and actual squadron Mission Capability Rates for the period of 01 April 2002 through 30 June 2002. Results suggest that although repairable parts are currently delivered quicker through the FIRST program, the contract measurement of SRT may not reflect any long-term improvements in F/A-18 E/F readiness.

**KEYWORDS:** Logistics, F/A-18 E/F, FIRST, Performance Metrics, Readiness, Operational Availability, Outsourcing

### **EXAMINATION OF RELIABILITY MANAGEMENT WITHIN THE MARINE CORPS ACQUISITION PROCESS**

**Marvin L. Norcross, Jr.-Captain, United States Marine Corps  
B.S., The Citadel, 1997**

**Master of Science in Management-December 2002**

**Advisor: Brad Naegle, Graduate School of Business and Public Policy**

**Associate Advisor: Keebom Kang, Graduate School of Business and Public Policy**

Combat system reliability is central to creating combat power, determining logistics supportability requirements, and determining systems' total ownership costs, yet the Marine Corps typically monitors only operational availability. While acceptable operational availability may be achieved through intensive maintenance and the stocking of needed repair parts in large quantities, this increases the logistics burden on the combat commander and is costly in terms of personnel, time, and funding.

Data required to compare system reliability requirements in source documents, such as the Operational Requirements Document and the acquisition contract, to achieved reliability of fielded systems is generally not collected, maintained, or available. Contractual obligations to attain system reliability, if any, could not be enforced, and any increase in sustainability costs associated with unmet reliability thresholds is borne by the Marine Corps, draining scarce funding from other priorities.

This research interprets data and perspectives, as collected from a reliability management survey administered to acquisition workforce professionals, and collectively summarizes common inhibitors of effective reliability management, why they occur, lessons learned, and potential methods for mitigating the inherent risks. The results ascertain a variety of technical, programmatic, managerial, incentive, and procedural issues that the Marine Corps encounters concerning system reliability requirements and achievement.

**KEYWORDS:** Reliability, Program Management, Acquisition Management, Life Cycle Cost, Life Cycle Management



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### **ENTERPRISE RESOURCE PLANNING (ERP): A CASE STUDY OF SPACE AND NAVAL WARFARE SYSTEMS CENTER SAN DIEGO'S PROJECT CABRILLO**

**Eric Oxendine-Lieutenant Commander, United States Navy**

**B.A., North Carolina University, 1992**

**Master of Science in Management-September 2002**

**Dean M. Hoffman, IV-Captain, United States Army**

**B.A., Lycoming College, 1991**

**Master of Science in Management-December 2002**

**Advisor: Lawrence R. Jones, Graduate School of Business and Public Policy**

**Second Reader: John E. Muttty, Graduate School of Business and Public Policy**

This thesis examines the Enterprise Resource Planning (ERP) pilot implementation conducted at the Space and Naval Warfare Systems Center San Diego (SSC-SD), the first of four Department of the Navy (DON) pilot implementations. Specifically, comparisons are drawn between both successful and unsuccessful ERP implementations within private sector organizations and that of SSC-SD. Any commonalities in implementation challenges could be applied to future ERP implementations in both the DON and Department of Defense (DOD).

The findings are based in part upon interviews and data collected. From the comparison, commonalities exist in ERP implementation challenges between private sector organizations and SSC-SD. Additionally the management techniques used to mitigate those challenges are similar. Finally, due to SSC-SD's financial management structure and appropriated funding constraints, unique obstacles were identified during the implementation. These unique obstacles will be encountered by other Working Capital Funded (WCF) organizations planning to implement ERP on the same scale as SSC-SD. This thesis supports that the implementation of ERP at SSC-SD was a success based on industry comparisons, the goals of Project Cabrillo's business case analysis (BCA), and its Chief Financial Officer (CFO) Act compliancy assessment, January 2002.

**KEYWORDS:** Enterprise Resource Planning, Financial Management, Project Cabrillo, Space and Naval Warfare Systems Center San Diego, SSC-SD

### **A COMPARATIVE ANALYSIS OF LEADERSHIP SKILLS DEVELOPMENT IN MARINE CORPS TRAINING AND EDUCATION PROGRAMS**

**Christopher L. Page-Major, United States Marine Corps**

**B.S., Drexel University, 1989**

**Master of Science in Management-December 2002**

**Scott H. Miller-Captain, United States Marine Corps**

**B.S., United States Merchant Marine Academy, 1993**

**Master of Science in Management-December 2002**

**Advisors: Alice Crawford, Graduate School of Business and Public Policy**

**Cary Simon, Graduate School of Business and Public Policy**

This thesis analyzes the perceptions of a non-random sample of 210 officers and enlisted Marines in two locations. A researcher-developed survey and semi-structured interviews were administered to ascertain opinions of Marines concerning leadership development. An analysis of the content of leadership training and education courses was also conducted. This information was compared to contemporary leadership theory and relevant models of leadership. In general, leadership development provided is adequate, but is lacking in some areas of skill development, application of skills and values, and relevancy to contemporary leadership issues. Professional Military Education (PME) generally provides relevant leadership training and education to enlisted personnel, but falls short of meeting the expectations of many officers.

**KEYWORDS:** Leadership, Core Values, Leadership Training and Education, Professional Military Education

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### **THE EXPORT ADMINISTRATION ACT OF 1979 AND COMPUTER EXPORTS TO THE PEOPLE'S REPUBLIC OF CHINA (PRC)**

**Elizabeth D. Perez-Captain, United States Marine Corps  
B.S., Santa Clara University, 1992**

**Master of Science in Management-December 2002**

**Advisor: Richard B. Doyle, Graduate School of Business and Public Policy**

**Associate Advisor: Ira A. Lewis, Graduate School of Business and Public Policy**

The importance of computers to the U.S. military and national defense is significant and multifaceted. The statute that regulates computer exports, the Export Administration Act of 1979 (EAA79), has been interpreted both strictly and loosely by policymakers, executive agencies, and export control regimes. The result has been a persistent struggle in balancing the competing interests of national security and commerce. An urgent need exists to rewrite EAA79, yet Congress has not been able to come to a consensus due to overlapping and conflicting committee interests within and across the chambers. While Congress continues to debate rewriting EAA79, the President has been able to adjust the impact of U.S. export control laws on foreign countries, utilizing export controls as means of advancing U.S. foreign policy abroad. In the case of the People's Republic of China, the White House has loosened export controls for high-performance computers to that country in order to encourage free trade and private enterprise.

**KEYWORDS:** Exports, Export Administration Act of 1979, Export Administration Act, Export Controls, Technology Transfer, Nonproliferation, Competitiveness, Multilateral Export Control Regimes, People's Republic of China, High-performance Computers, Computers

### **AN ANALYSIS OF THE COMMON MISSILE AND TOW 2B ON THE STRYKER ATGM PLATFORM, USING THE JANUS SIMULATION**

**Samuel L. Peterson-Major, United States Army**

**B.S., University of Tampa, 1991**

**Master of Science in Management-December 2002**

**Advisor: David F. Matthews, Graduate School of Business and Public Policy**

**Associate Advisor: Keebom Kang, Graduate School of Business and Public Policy**

The U.S. Army is beginning to field the first of six Stryker Brigade Combat Teams (SBCTs) and equip the organic Anti-Tank (AT) Company of the Brigade with the LAV III Anti-Tank Guided Missile (ATGM) Platform and the Tube-Launched, Optically-Tracked, Wire-Guided 2B (TOW 2B) missile system. A developmental effort is currently underway to replace the aging TOW 2B and Hellfire missile systems with a common missile that meets both ground and air requirements. With increased range, lethality, and target acquisition capability, the Common Missile (CM) is being designed as the primary weapon system for the Army's Comanche helicopter and is a candidate for the lethality system of the Future Combat System (FCS) within the Army's Objective Force. Additionally, the CM is designed to be "backwards compatible" with existing TOW 2B and Hellfire launch platforms. The objective of this research effort is to determine the increase in operational effectiveness through the employment of the CM in the AT company of the SBCT in three different scenarios, using the high-resolution Janus Combat Model. Operational effectiveness will be assessed and statistically analyzed using lethality, survivability, and engagement range for three measures of effectiveness (MOEs).

**KEYWORDS:** Anti-Tank Guided Missile (ATGM), Army Transformation, Common Missile, Interim Brigade Combat Team (IBCT), Janus, Light Armored Vehicle III (LAV III), Modeling and Simulation, Stryker Brigade Combat Team (SBCT), TOW 2B Missile

## **MANAGEMENT**

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### **BUDGET PREPARATION, EXECUTION AND METHODS AT THE MAJOR CLAIMANT/BUDGET SUBMISSION OFFICE LEVEL**

**James E. Reed-Commander, United States Navy**

**B.B.A., University of North Florida, 1986**

**Master of Science in Management-December 2002**

**Advisor: Jerry L. McCaffery, Graduate School of Business and Public Policy**

**Associate Advisor: John E. Muttu, Graduate School of Business and Public Policy**

This thesis describes the current Planning, Programming, and Budgeting System (PPBS) process at a Navy Major Claimant/Budget Submitting Office (BSO) by examining the overall navy processes and the process employed at a major claimant/BSO, COMPACFLT (CPF). The thesis begins by describing the scope of the Planning, Programming, and Budgeting requirements at CPF by describing its Area of Responsibility (AOR) and the major sub-claimants who rely on CPF for program and budget submissions and subsequent allocation of resources. The thesis then describes the current Navy PPBS process, the process at CPF, and the interactions that occur between the two. Next, the thesis describes and analyzes the concurrent program/budget process implemented by the Secretary of Defense in August 2001 and the perceptions among CPF staff for the reasoning behind the change. The thesis also examines the differences in funding between readiness accounts that directly support operating forces and support accounts that provide resources to the infrastructure account that supports those forces. Finally, the thesis discusses the intricate, yet reiterative nature of the process and the informal PPBS process that occurs between participants on a day-to-day basis. This thesis was prepared by reviewing current documentation of the PPBS process and by conducting interviews with key members of the CPF planning, programming and budgeting staffs.

**KEYWORDS:** Planning Programming and Budgeting System (PPBS), Capability Plans (CP), Integrated Warfare Architectures (IWAR), Budget

### **AN ANALYSIS OF ELECTRONIC COMMERCE ACQUISITION SYSTEMS: COMPARISON OF A NEW PURE ELECTRONIC PURCHASING AND EXCHANGE SYSTEM (ELECTRONIC STOREFRONT) AND OTHER LEGACY ON-LINE PURCHASING SYSTEMS**

**Arthur T. Rowe-Lieutenant Commander, United States Navy**

**B.S., University of South Carolina, 1991**

**Master of Science in Management-December 2002**

**Advisor: Ron B. Tudor, Graduate School of Business and Public Policy**

**Second Reader: CDR James Barnard, USN, Graduate School of Business and Public Policy**

This research will evaluate purchasing problems and issues in current on-line contracting/procurement programs including GSA Advantage, DoD E-Mall, and other current on-line purchasing programs as they relate to contracting and purchasing of supplies and services. The issues and concerns with legacy on-line procurement systems will be compared to a newly developed Pure Electronic Ordering System (Electronic Storefront) recently developed by Professor Ron Tudor and students at the Naval Postgraduate School. This new program is currently under testing by a prime contractor under the auspices of the Department of Interior. The new on-line contracting/procurement program will allow Federal, State and Local Government users to purchase supplies and services on-line through the use of the Internet, through the use of electronic catalogs and embedded contract templates. This thesis will consider some of the functions of the new program and how the new program addresses the issues and concerns identified under the current legacy on-line procurement programs as well as additional benefits the new program will encompass compared to legacy systems.

**KEYWORDS:** Procurement, E-commerce, E-procurement

## **MANAGEMENT**

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### **AN ANALYSIS OF CURRENT AND PROPOSED OVERSIGHT PROCESSES FOR THE ACQUISITION OF LARGE-SCALE SERVICES AS SEEN THROUGH THE EYES OF THE NAVY MARINE CORPS INTRANET PROGRAM**

**JoCephas Rozier-Major, United States Marine Corps**

**B.S., University of Akron, 1987**

**Master of Science in Management-December 2002**

**Advisor: Marshall Engelbeck, Graduate School of Business and Public Policy**

**Second Reader: Ron Tudor, Graduate School of Business and Public Policy**

At approximately \$6.9 billion, the Navy-Marine Corps Intranet (NMCI) was the largest service contract that DoD had ever awarded. The U.S. Navy viewed it as a typical multi-year, Performance Based Services Contract (PBSC) and not a new acquisition program. Congress took a different view. Congress attached milestones, conditions, a requirement for rigorous testing and limited funding. This all had the effect of delaying the implementation of NMCI. At approximately \$60 billion per year and growing, acquisition of services is a major part of DoD acquisitions and it is expected to only grow in the future. The mechanics for implementing these types of acquisitions are well understood; the U.S. Navy's experience with NMCI suggests that the amount and type of oversight required are not as well defined. Realizing this, both DoD and the U.S. Congress are scrambling to create laws and policies to bridge this gap. The commercial section has considerable experience in this area, as acquisition of services is a growing endeavor there too. This thesis examines current and proposed policy and procedures for the oversight of the acquisition of large-scale services by the DoD, along with a brief analysis of and comparison to other best practices regarding service acquisition.

**KEYWORDS:** Acquisition of Services, Navy-Marine Corps Intranet (NMCI), Performance Based Services Acquisition (PBSA), Performance Based Services Contracts (PBSC), Services Acquisition Reform Act (SARA), Services Contracts Oversight Process (SCOP), Contracting

### **COSTS AND BENEFITS OF USING FUEL CELL FOR STATIONARY POWER GENERATION AT MARINE CORPS LOGISTICS BASE BARSTOW**

**Phillip J. Schendler-Captain, United States Marine Corps**

**B.S., United States Naval Academy, 1994**

**Master of Science in Management-December 2002**

**Advisor: William R. Gates, Graduate School of Business and Public Policy**

**Second Reader: David R. Henderson, Graduate School of Business and Public Policy**

The costs and benefits of using two types of fuel cell power generation systems versus Southern California Edison to provide the base electricity load for the Marine Corps Logistics Base Barstow Maintenance Center are compared. The results indicate that the break-even point is not likely to occur before year eight and under certain conditions may not occur at all during the 20-year program life cycle. The results do indicate a pollution reduction from fuel cells, but the reduction would not have any measurable impact on the nation's air quality.

**KEYWORDS:** Fuel Cell, Electricity, Power Generation, Barstow, Deregulation, California

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## MANAGEMENT

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### THE STRATEGIC DISTRIBUTION MANAGEMENT INITIATIVE AND ITS EFFECTS ON INVENTORY LEVELS AND READINESS

Jeffrey A. Schmidt-Lieutenant Commander, United States Navy  
B.S., Pennsylvania State University, 1991

Master of Science in Management-December 2002

Devon D. NuDelman-Captain, United States Army  
B.A., University of Missouri-Saint Louis, 1993

Master of Science in Management-December 2002

Advisor: Don Eaton, Graduate School of Business and Public Policy

Associate Advisor: Ken Doerr, Graduate School of Business and Public Policy

Until just a few years ago, no organization was tasked with measuring overall effectiveness, design, or optimization of DOD's global supply chain management system. As a result, the Strategic Distribution Management Initiative (SDMI) was created as a joint venture between Defense Logistics Agency (DLA) and the United States Transportation Command (USTRANSCOM) charged with enterprise level redesign, streamlining, and optimization of the DOD global supply chain. This thesis examines the affects of the SDMI implementation on the Army's two maneuver divisions stationed in the Europe. Specifically, it analyzes affects of SDMI implementation on the eight supply support activities located within the two maneuver divisions in USAREUR.

This thesis studies SDMI impacts on inventory levels; inventory turbulence in the SSAs during SDMI implementation; SDMI improvements with respect to readiness; and existing barriers to improving velocity. The research indicates that: (1) expected inventory reductions were not realized following SDMI implementation, (2) inventory turbulence consumes limited resources and is a lucrative target for further improvement, (3) there is no evidence that SDMI increased fleet readiness, and (4) backorder rates and time, along with sub-optimization of pieces of the DOD supply chain, are significant barriers to velocity that still must be broken through.

**KEYWORDS:** Strategic Distribution Management Initiative, SDMI, Defense Logistics Agency (DLA), United States Transportation Command, USTRANSCOM, Logistics

### THE HORIZON OF FINANCIAL MANAGEMENT FOR THE DEPARTMENT OF DEFENSE

John W. Skarin-Lieutenant, United States Navy  
B.S., United States Naval Academy, 1995

Master of Science in Management-December 2002

Advisor: Jerry L. McCaffery, Graduate School of Business and Public Policy

Associate Advisor: John E. Muttu, Graduate School of Business and Public Policy

The Department of Defense (DOD) has been unable to complete a financial audit since the enactment of the Accounting and Auditing Act of 1950, requiring periodic audits of all federal agencies. With corporate accounting scandals such as Enron, WorldCom and Xerox fresh in America's mind, Congress has given high priority to examining DOD's financial management situation, their plans for improvement, and ensuring taxpayer money can be accounted for throughout the department. This thesis will examine the root causes behind DOD's perceived wasteful culture, failed attempts to remedy the situation, the top 10 obstacles impeding proper financial management, and the outlook for attaining and passing an audit based on current strategy. In addition, this thesis will analyze the complexity of DOD budget execution and why budgets are rarely executed as written. With a slowing economy and other federal departments forced to do more with less, a more efficient financial structure could free billions of dollars.

**KEYWORDS:** Financial Management, Department of Defense, Budget Execution

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## MANAGEMENT

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### **AN ANALYSIS OF THE DEPARTMENT OF THE AIR FORCE, ARMY, AND NAVY BUDGET OFFICES AND BUDGET PROCESSES**

**Brian R. Taylor-Captain, United States Marine Corps  
B.S., United States Naval Academy, 1997**

**Master of Science in Management-December 2002**

**Advisor: Jerry L. McCaffery, Graduate School of Business and Public Policy**

**Associate Advisor: John E. Muttly, Graduate School of Business and Public Policy**

The objective of each of the budget offices of the Departments of the Air Force, Army, and Navy is to create a budget request to be submitted to the Secretary of Defense for incorporation in the President's budget. The primary objective of this thesis is to familiarize the reader with the composition and responsibilities of these budget offices in order to demonstrate how they meet this objective. The focus of this thesis will be on the Department of the Navy and the subordinate of the two services of which it is composed, the Marine Corps. This thesis will use a macro to micro process providing an overview of the Planning, Programming, and Budgeting System at the Department of Defense level, a summary of each department's budget office to include their composition and responsibilities, a description of the appropriation processes of the Department of the Navy and a summation of the Marine Corps budgetary process. This process will ensure that the reader sees how a budget is developed, on all levels, from the all-encompassing DOD to the smallest of the services the Marine Corps. The process described in this thesis reflects the timelines in place prior to August 2001. Although the timelines have changed, the process remains essentially the same.

**KEYWORDS:** Planning, Programming, and Budgeting System (PPBS), Budget Offices, Department of the Navy Appropriations, Marine Corps Program Objective Memorandum (POM)

### **ANALYSIS OF FOR-PROFIT COMMERCIAL FIRM PARTICIPATION IN TECHNOLOGY INVESTMENT AGREEMENTS**

**Barbara D. Tucker-Lieutenant Commander, United States Navy  
B.S., United States Naval Academy, 1989**

**Master of Science in Management-December 2002**

**Advisor: Ron Tudor, Graduate School of Business and Public Policy**

**Second Reader: LTC Rodney E. Tudor, USA, Graduate School of Business and Public Policy**

In this thesis, data provided in a 1999 Inspector General Audit on "other transactions" as well as Dual Use Science and Technology (DU S&T) Program projects from 1997 through 2001 are analyzed. Technology Investment Agreements (TIAs) were found to have attracted for-profit commercial firms that normally do not do business with the Government into participating in research projects with the Department of Defense (DoD). The average for-profit commercial firm participation rate of DU S&T projects was found to be 26.2 percent. A sample TIA and a sampling of DU S&T project participants are included as appendices.

**KEYWORDS:** Technology Investment Agreement, Other Transactions, Non-traditional Defense Suppliers

### **ANALYSIS OF CHARACTERISTICS IN THE DEFENSE SUPPLEMENTAL APPROPRIATIONS**

**Philip G. Urso-Lieutenant, United States Navy  
B.A., University of Colorado-Boulder, 1995**

**Master of Science in Management-December 2002**

**Advisor: Jerry L. McCaffery, Graduate School of Business and Public Policy**

**Associate Advisor: John E. Muttly, Graduate School of Business and Public Policy**

The supplemental appropriation may be used as a budgetary tool for funding requirements. This study examined how the supplemental affected the Department of Defense (DoD) from fiscal year 1996 to fiscal year 2000. Furthermore, it examined the nature of the supplemental by studying its characteristics. Defense budgetary spending caps mandate that supplemental spending remain under certain limits. However, the use of the "emergency" designation has been a useful tool in expanding the amount of funds

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that the DoD may utilize. During the time of this study, the supplemental grew both in amounts and in the usage of the contingent emergency designation. In some cases, the President initiated supplemental spending, but in the latter years, it appeared that Congress took the lead. Furthermore, the need for supplementals went beyond one-time expenditures. Supplemental funding became a need to ensure readiness while the number of requirements grew and the emergency designation helped to make that possible.

**KEYWORDS:** Supplemental Appropriations, Emergency Appropriations, Rescissions, Budget Strategy



# **MASTER OF SCIENCE IN MECHANICAL ENGINEERING**

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## **OBSTACLE AVOIDANCE CONTROL FOR THE REMUS AUTONOMOUS UNDERWATER VEHICLE**

**Lynn Renee Fodrea-Lieutenant, United States Navy  
B.S., United States Naval Academy, 1998**

**Master of Science in Mechanical Engineering-December 2002**

**Advisor: Anthony J. Healey, Department of Mechanical Engineering**

Future Naval operations necessitate the incorporation of autonomous underwater vehicles into a collaborative network. In future complex missions, a forward look capability will be required to map and avoid obstacles such as sunken ships. This thesis examines obstacle avoidance behaviors using a forward-looking sonar for the autonomous underwater vehicle *REMUS*. Hydrodynamic coefficients are used to develop steering equations that model *REMUS* through a track of specified points similar to a real-world mission track. Control of *REMUS* is accomplished using line of sight and state feedback controllers. A two-dimensional forward-looking sonar model with a 120° horizontal scan and a 110 meter radial range is modeled for obstacle detection. Sonar mappings from geographic range-bearing coordinates are developed for implementation in MATLAB simulations. The product of bearing and range weighting functions form the gain factor for a dynamic obstacle avoidance behavior. The overall vehicle heading error incorporates this obstacle avoidance term to develop a path around detected objects. *REMUS* is a highly responsive vehicle in the model and is capable of avoiding multiple objects in proximity along its track path.

**KEYWORDS:** *REMUS*, Underwater Vehicle, Obstacle Avoidance, AUV

## **MOTION ANALYSIS OF A TROLLEY INTERFACE FOR SHIP-TO-SHIP CARGO TRANSFER**

**Brian E. Higgins-Lieutenant, United States Coast Guard  
B.S., United States Coast Guard Academy, 1995**

**Master of Science in Mechanical Engineering-December 2002**

**Advisor: Fotis A. Papoulias, Department of Mechanical Engineering**

The goal of this thesis is to investigate the effectiveness of a trolley interface for ship-to-ship cargo transfer. The new interface alleviates some of the torsional problems associated with existing ramp designs and can be effectively utilized for both skin-to-skin and Roll-On Roll-Off operations. A mathematical model is developed in order to predict cargo transfer rates in a seaway. Three dimensional hydrodynamic analysis data are used to calculate expected transfer rates in a seaway between a ship and a discharge facility. Results are presented in standard fully developed Pierson Moskowitz sea spectra. It is shown that the new design is a viable alternative to existing methods.

**KEYWORDS:** Advanced Design Consulting Inc., Hydrodynamic Analysis, Pierson-Moskowitz, Ramp Design, Seabasing, Trolley Interface, WAMIT



## **MECHANICAL ENGINEERING**

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### **TRACKING CONTROL OF AUTONOMOUS UNDERWATER VEHICLES**

**Joseph J. Keller-Lieutenant, United States Navy**

**B.S.M.E., San Diego State University, 1994**

**Mechanical Engineer-December 2002**

**Master of Science in Mechanical Engineering-December 2002**

**Advisor: Anthony J. Healey, Department of Mechanical Engineering**

Recovery of Autonomous Underwater Vehicles (AUVs) can often be an autonomous operation itself. In the case of an AUV that is launched and recovered at some significant depth below the surface, the recovery platform to which the vehicle will dock is often not a stationary platform. The recovery cage/platform has dynamics associated with it which are induced by wave motion effects on the ship to which the cage is tethered. In order to successfully recover a vehicle into a cage platform it will be preferred for the vehicle to have the capability to compensate for this motion when making its final approach to the cage. Using active compensation, a smaller cage can be utilized for recovery of an AUV. This research attempts to investigate a means by which a vehicle may be made to track, in depth, dynamic motion with zero phase lag between the vehicle and the recovery platform utilizing an error space controller.

**KEYWORDS:** Underwater Vehicle, AUV, Tracking, Control, Error Space Control, AUV Parameter Identification, AUV Recovery

### **NONLINEAR DYNAMICS OF CLOSE PROXIMITY SHIP TOWING**

**Murat Korkut-Lieutenant Junior Grade, Turkish Navy**

**B.S., Turkish Naval Academy, 1997**

**Master of Science in Mechanical Engineering-December 2002**

**Advisor: Fotis A. Papoulias, Department of Mechanical Engineering**

The goal of this study is to investigate the nonlinear dynamics of two ships in close proximity towing. The sway and yaw dynamics of both the leading and the trailing ships were included in the formulation. Previous studies were restricted to a linear analysis, which can accurately predict the regions of stability and instability for the system. The mechanism of loss of stability can be assessed with a systematic nonlinear analysis. The analysis is based on Taylor series expansions of the equations of motion up to third order terms. It is shown that the primary loss of stability occurs in the form of Hopf bifurcations to periodic solutions. A nonlinear stability coefficient was calculated which allows characterization of the stability properties of the resulting limit cycles. The results indicate the effects of ship separation and towing tension on motion stability.

**KEYWORDS:** Directional Stability, Nonlinear Dynamics, Towing

### **A NUMERICAL STUDY OF COMBINED CONVECTIVE AND RADIATIVE HEAT TRANSFER IN A ROCKET ENGINE COMBUSTION CHAMBER**

**Mehmet Koray Savur-Lieutenant Junior Grade, Turkish Navy**

**B.S., Turkish Naval Academy, 1997**

**Master of Science in Mechanical Engineering-December 2002**

**Advisor: Ashok Gopinath, Department of Mechanical Engineering**

A numerical study was conducted to predict the combined convective and radiative heat transfer rates on the walls of a small aspect ratio cylinder representative of the scaled model of a rocket engine combustion chamber. A high-temperature, high-pressure environment was simulated in the cylinder, with gas velocities at low subsonic levels typical of the conditions leading to the entrance of the nozzle section of a rocket engine. The composition of the gases in the cylinder was determined from the TEP program for the burning of rocket fuel at typical values of the O/F ratio. The thrust of the study was to determine the radiative contribution to the heat transfer rate from the hot participating chamber gases to the cooler wall. The calculations were carried out using the commercial CFD package, CFDACE, and were first benchmarked

against known results in the literature for the simpler case of gray chamber walls and a gray participating medium. The non-gray computations were subsequently carried out using gas absorption coefficient values obtained from the exponential wide band model with the help of the fire-modeling program, RADCAL. The effect of different chamber wall temperatures and gas compositions was examined. The main findings of the study are that the radiative contributions at the high gas temperatures being considered are comparable to the convective values, and strongly spectral in nature. Furthermore, this radiative contribution reaches a maximum at a unique optimal optical thickness of the gas that lies within the extremes of the optically thin and thick limiting cases.

**KEYWORDS:** Radiative Heat Transfer, Rocket Engine, Combustion Chamber, RADCAL, TEP, CFD-ACE, Non-gray Gas, Spectral Transmissivity, Absorption Coefficient



# **MASTER OF SCIENCE IN METEOROLOGY AND PHYSICAL OCEANOGRAPHY**

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## **METOC AND NAVAL AFLOAT OPERATIONS: RISK MANAGEMENT, SAFETY, AND READINESS**

**Brett S. Martin-Lieutenant Commander, United States Navy  
B.S., State University of New York, 1991**

**Master of Science in Meteorology and Physical Oceanography-December 2002**

**Advisor: Tom Murphree, Department of Meteorology**

**Second Reader: Carlyle H. Wash, Department of Meteorology**

The METOC aspects of ORM, safety, and readiness in Naval afloat operations were investigated. The purpose of this work was to identify and develop methods by which the METOC community can better contribute to these components of Naval operations. Records of class A, B and C afloat mishaps during March 1997 – March 2002 from the NSC were the primary data source for this study. The major objectives in analyzing this data were to identify: (1) METOC related mishaps (MRMs); (2) the costs of these mishaps; and (3) the phenomenological and operational conditions under which these mishaps occurred. 166 MRMs during the study period were identified. The major average costs of these mishaps were: (1) 1.5 deaths per year; (2) 16 days of lost duty per MRM; (3) 11 days of light duty per MRM; (4) 150 days of lost or light duty per year due to MRMs involving small boat operations; and (5) \$54,000 in equipment damage per MRM. The major METOC phenomena involved in underway MRMs were high winds and seas, which occurred in over half the MRMs. Eighty-four percent of the MRMs involved deficiencies in training on how to deal with adverse METOC conditions.

**KEYWORDS:** Naval Afloat Mishaps, METOC Phenomena, Human Error, Accident Classification, Accident Analysis, Surface Weather, Operational Risk Management (ORM), Readiness



# **MASTER OF SCIENCE IN OCEANOGRAPHY**

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## **ASSESSING THE PERFORMANCE OF OMNI-DIRECTIONAL RECEIVERS FOR PASSIVE ACOUSTIC DETECTION OF VOCALIZING ODONTOCETES: INITIAL ANALYSIS**

**Jorge F. Garcia-Lieutenant, United States Navy**

**B.S., United States Naval Academy, 1995**

**Master of Science in Oceanography-December 2002**

**Advisor: Ching-Sang Chiu, Department of Oceanography**

**Second Reader: Curtis Collins, Department of Oceanography**

The purpose of this study was to evaluate the performance of inexpensive, passive, omni-directional receivers as a means to detect vocalizing Odontocetes using conditional statistics. To evaluate and predict performance, it was necessary to establish probability of detection as a function of: a) signal to noise ratio or range at a given source level, and b) probability of false alarm. For this purpose, a model of the probability distribution function of the detector output was derived from experimental data. For the experiment a series of short duration digital recordings of selected odontocete vocalizations were broadcast underwater from a moving platform. The vocalizations were monitored and digitally recorded at a stationary underwater array consisting of three vertically distributed hydrophones. Over a period of three days, several hundred iterations of each signal – with the transmitter at ranges varying from 300 meters to 12000 meters – were recorded. A monitoring hydrophone (co-located with the transmitter) was used to monitor the signal source level. The raw data was fed to two “automatic detectors” consisting of different data processing routines developed in MATLAB®. The output of each detector was subjected to statistical analysis. Other factors also considered in the analysis were: signal used, range, and wind (as a proxy indicator of noise generated by surface wave action). A statistical test was employed to systematically find a best fit probability distribution function model of detector output. From this empirical model, detector performance was estimated.

**KEYWORDS:** Acoustics, Passive Detection, Marine Mammal, Odontocete, Omni-directional Hydrophone



# **MASTER OF SCIENCE IN OPERATIONS RESEARCH**

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## **APPLYING A FIX-AND-RELAX HEURISTIC TO U.S. NAVY FORCE STRUCTURE PLANNING**

**Mehmet Aytekin-Lieutenant Junior Grade, Turkish Navy**

**B.S., Turkish Naval Academy, 1997**

**Master of Science in Operations Research-December 2002**

**Advisor: Javier Salmeron, Department of Operations Research**

**Second Reader: Robert F. Dell, Department of Operations Research**

Capital Investment Planning Aid (CIPA) is an optimization-based decision support system created for the U.S. Navy to help plan yearly force structure procurement and retirement. CIPA constraints include yearly industrial and budget limits, as well as mission inventory and force mix requirements. Over a 30-year planning horizon, CIPA helps plan over \$1 trillion. Several approaches have been proposed and implemented to solve the CIPA core, a mixed-integer linear program (MILP). Unfortunately, some of these MILPs cannot be solved in a reasonable amount of time using general-purpose commercially available optimization software. This thesis presents a new MILP-based heuristic technique, fix-and-relax, that yields good quality solutions and reduces the computational solution time for the set of realistic test cases.

**KEYWORDS:** Operations Research, Capital Investment Planning Aid, CIPA, Heuristic, Optimization, Integer Linear Programming

## **BARRIER PATROL AND AIR DEFENSE SYSTEM: DEVELOPING AND INTEGRATING FLIGHT PROFILES**

**Luiz Alberto Pereira Bianchi-Major, Brazilian Air Force**

**B.S., Brazilian Air Force Academy, 1985**

**Master of Science in Operations Research-December 2002**

**Advisor: Steven E. Pilnick, Department of Operations Research**

**Second Reader: Thomas H. Hoivik, Department of Operations Research**

In order to support the Brazilian Air Defense System, principally, in the Amazon region, the Brazilian Air Force has recently acquired the R-99, Airborne Warning and Control System (AWACS). This aircraft and the types of missions it can support are innovative in the Brazilian Air Force. The R-99 will be used for patrolling the Brazilian borders and interception control of illicit air traffic in the Amazon region. This thesis develops a planning tool, called the Campaign Decision Aid, to optimize the utilization of the R-99 in its search and detection mission. Basic principles of Radar Theory and simple Search and Detection models are used to support the analytical evaluation and optimal selection of the R-99 patrolling flight profiles. Also, stochastic modeling theory is used to develop measures of effectiveness to evaluate the integrated effort of detaining the illegal traffic using interceptors, which are flown from pre-determined Air Bases in the Amazon Region. Utilization of this Campaign Decision Aid will contribute to the control and integrity of Brazilian territory.

**KEYWORDS:** Air Defense, Patrolling Optimization, Measures of Effectiveness, AWACS, Air Surveillance



# OPERATIONS RESEARCH

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## OPTIMIZATION MODELS FOR ALLOCATION OF AIR STRIKE ASSETS WITH PERSISTENCE

Davi R. S. Castro-Major, Brazilian Air Force

B.S., Brazilian Air Force Academy, 1987

E.E., Aeronautical Institute of Technology, Brazil, 1996

Master of Science in Operations Research-December 2002

Advisor: Richard E. Rosenthal, Department of Operations Research

Second Reader: R. Kevin Wood, Department of Operations Research

The explosion of information available to decision-makers at all levels on the battlefield has led to tremendous strides in the ability to process, decide and act. At the same time, there is increasing demand for faster and better decisions. This thesis addresses one type of critical decision that must be made quickly and effectively, namely how to assign strike aircraft to targets once the targets have been identified. More specifically, the primary questions that this research attempts to answer are:

"How do we optimally employ available aircraft and weapons on the current set of targets?"

"How can we modify a previously optimized assignment list to face changes in the tactical situation, in a manner that balances the desire to obtain a new optimal solution with the desire to minimize disruption of existing plans based on the previous solution?"

The general air strike planning problem is divided into five areas: target selection, weapon allocation, mission formation and assignment, mission routing and scheduling, and contingency planning. This thesis addresses weapon allocation, and mission allocation and assignment, for the aircraft of an air strike package (the "package" will typically contain other aircraft with non-strike roles such as suppression of enemy air defense; these aircraft are not directly considered in this thesis).

Contributions to the strike-planning problem include: (1) a static allocation model in which each aircraft makes at most one sortie during the planning time horizon, (2) a dynamic model in which each aircraft may make more than one sortie during that horizon, and (3) extensions of these models with "persistence incentives," which discourage major changes in the results when partial but important changes in the tactical situation necessitate reoptimization. All of these models are mixed-integer programs.

These models are demonstrated in realistic scenarios. For instance, these models can allocate 156 air assets from seven bases to 100 targets in just few seconds on a personal computer. This particular problem has three types of aircraft and two possible weapons configurations for each aircraft. There are three types of weapons and 20 different packages can be formed from the aircraft available.

The persistence paradigm plays an important role in this thesis. It is shown that a new optimal plan can differ drastically from a previous plan after only small changes in the tactical situation. To handle these unexpected changes more conveniently, the persistent model adds a term to the original objective function that penalizes deviations from the original plan. The new plan is nearly optimal in the standard sense, and unit-level planners and pilots have fewer plan changes to handle.

This research is performed under the sponsorship and guidance of SPAWAR (Space and Naval Warfare Center). The result of this work is to be used inside REDS (Real-Time Execution Decision Support), a decision-support tool currently being developed at SPAWAR under sponsorship of the Office of Naval Research. The optimization modeling developed in this thesis will support SPAWAR's goal of having REDS provide the best solution for allocation of strike assets in a dynamic tactical environment.

**KEYWORDS:** Air Tasking Orders, ATO, Weapon Allocation, Strike Package, Persistence, Mixed-Integer Program, MIP, Optimization, Operations Research

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## OPERATIONS RESEARCH

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### A BRANCH-AND-BOUND ALGORITHM FOR THE NETWORK DIVERSION PROBLEM

Ozgur Erken-Lieutenant Junior Grade, Turkish Navy

B.S., Turkish Naval Academy, 1997

Master of Science in Operations Research-December 2002

Advisor: R. Kevin Wood, Department of Operations Research

Second Reader: W. Matthew Carlyle, Department of Operations Research

In the network diversion problem (NDP), a minimum-weight set of edges in a directed graph  $G = (V, E)$  whose deletion forces all  $s$ - $t$  communication to pass through one or more diversion edges in a diversion set  $E_D$  must be found. A specialized branch-and-bound algorithm for this NP-complete problem was developed and tested. The algorithm is based on partitioning the solution space with respect to edges in certain  $s$ - $t$  cuts and yields a non-standard, non-binary enumeration tree. The algorithm is coded in Java version 1.4 and run on a 1.5 MHz Pentium IV computer with 384 megabytes of RAM. An instance of NDP on a grid graph with 2502 vertices, 9900 edges and one diversion edge is solved in 5.66 seconds; the same problem with 10 diversion edges is solved in only 0.84 seconds.

**KEYWORDS:** Networks, Cuts, Network Diversion, Simple Path, Enumeration, Branch-and-bound

### THE EFFECT OF SENSOR PERFORMANCE ON SAFE MINEFIELD TRANSIT

Chihoon Kim-Lieutenant, Republic of Korea Navy

B.S., Republic of Korea Naval Academy, 1994

Master of Science in Operations Research-December 2002

Thesis Advisor: Steven E. Pilnick, Department of Operations Research

Co-Advisor: Patricia A. Jacobs, Department of Operations Research

Donald P. Gaver, Department of Operations Research

Mines are relatively cheap weapons that can be employed in significant quantity by any country with even a modest military budget, and can be very effective at severely damaging or sinking ships or denying maritime access to an area. In this thesis, simulation and analytical models are formulated and studied to investigate the benefits and risks of mine avoidance, without object classification capability, under circumstances that include imperfect sensors and false targets. Two models of mine avoidance maneuvering are formulated, with increasing complexity in both their analytical and simulation implementations. With both formulations, results are obtained and analyzed to produce tables showing the probability of successful minefield transit as a function of sensor probability of detection vs. density of mine and non-mine, mine-like bottom objects, and the false alarm rate. The tables show the range of those parameter values for which mine avoidance maneuvering improves the probability of safe transit, and the values for which mine avoidance maneuvering reduces the probability of safe transit. The decrease is attributable to the fact that mine avoidance maneuvering increases the distance traveled in the minefield and the consequent risk of damage or destruction by an undetected mine. Quantitative results for the increased distance traveled in the minefield are also presented. Finally, a comparison of the two models of mine avoidance maneuvering show, not surprisingly, that the results of the simpler model are not good approximations of the results obtained with the more complex model, suggesting that even greater complexity in maneuver modeling may be desirable for some purposes.

**KEYWORDS:** Mine, Minefield, NOMBO, Simulation, Stochastic Model, ROC Curve Model, Simkit, JAVA



# MASTER OF SCIENCE IN PHYSICS

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## MEGAWATT CLASS FREE ELECTRON LASERS FOR NAVAL APPLICATION – SHORT RAYLEIGH LENGTH AND STABILITY ANALYSIS

Thomas E. Campbell-Lieutenant, United States Navy  
B.S., Auburn University, 1995

Master of Science in Physics-December 2002

Advisor: William B. Colson, Department of Physics

Second Reader: Robert L. Armstead, Department of Physics

A MW class free electron laser capable of delivering energy at the speed of light can improve ASCM defensive capability for Navy ships. Many design challenges must be overcome to make such a weapon possible. One such challenge is to maintain the power density on laser cavity mirrors at acceptable levels. The use of a short Rayleigh length to increase beam spot size at the mirror is studied as a possible solution to this problem. In this thesis, it is shown that by using a short Rayleigh length FEL, power densities at the mirrors are significantly reduced without causing a noticeable reduction in performance.

For a short Rayleigh length FEL, the resonator cavity is sensitive to misalignment and vibration. The effect of mirror tilt due to vibrations is explored and the results show that as mirror tilt increases, FEL efficiency does decrease. However, a mirror tilt several orders of magnitude greater than currently achievable active alignment tolerances is required before the FEL efficiency is noticeably affected. In this thesis, it is shown that mirror tilt within achievable tolerance limits will not adversely affect the performance of a FEL.

**KEYWORDS:** Free Electron Laser, Short Rayleigh Length, Directed Energy Weapon, Mirror Stability

## PASSIVE DETECTION OF GASES IN THE ATMOSPHERE CASE STUDY: REMOTE SENSING OF SO<sub>2</sub> IN THE UV USING LINUS

Anastasios G. Halvatzis-Major, Hellenic Air Force  
B.S., Hellenic Air Force Academy, 1988

B.S., University of Macedonia-Thessaloniki, 1995

Master of Science in Physics-December 2002

Advisor: Richard C. Olsen, Department of Physics

Second Reader: Richard Harkins, Department of Physics

An imaging UV spectrometer was used to study sulfuric plumes at Lassen Volcanic National Park, in an effort to identify and quantify SO<sub>2</sub> presence. The NPS instrument, LINUS (Lineate Imaging Near-Ultraviolet Spectrometer), was taken to Lassen on September 13 and 14, 2002. Data taken there are compared to laboratory measurements of SO<sub>2</sub> subsequently run at NPS. These data, along with additional measurements of platinum discharges for wavelength calibration, allow for comparison with atmospheric modeling calculations. Observations were modeled with the standard MODTRAN code. Comparisons between simulated and measured data showed minor indications of SO<sub>2</sub> in the Lassen data. The gas concentration was estimated to be less than 10ppmv.

**KEYWORDS:** Gas Detection, Sulfur Dioxide, Remote Sensing, Ultraviolet (UV), LINUS, Spectral Imager, MODTRAN

# PHYSICS

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## MEGAWATT CLASS FREE ELECTRON LASERS FOR NAVAL APPLICATION- SHORT RAYLEIGH LENGTH AND STABILITY ANALYSIS

William J. Ossenfort, Jr.- Lieutenant, United States Navy

B.S., Auburn University, 1994

Master of Science in Physics-December 2002

Advisor: William B. Colson, Department of Physics

Second Reader: Robert L. Armstead, Department of Physics

The free electron laser (FEL) is theoretically capable of scaling up to a MW class laser for naval point defense. At such high power levels, the FEL's optics could be damaged. An FEL operating with a short Rayleigh length reduces intensity at the mirrors; however, the performance of short Rayleigh length FELs is unknown. This thesis presents simulations of Thomas Jefferson Laboratories' proposed 100 kW FEL operating with a short Rayleigh length, and of a proposed 1 MW FEL undergoing shipboard induced mirror vibrations. In the 100 kW FEL, Rayleigh lengths of  $0.1L$  to  $0.5L$  (where  $L$  is the undulator length) were simulated. Weak field gain increases as Rayleigh length decreases, indicating that short Rayleigh length FELs will start from spontaneous emissions. Final FEL efficiency also increases as Rayleigh length decreases, with the exception of a spike at the typical Rayleigh length design value of  $0.3L$ . For the 1 MW FEL system, the high operating current acts to stabilize the optical mode against vibrations that result in mirror tilts of 0 to 400 microradians, where final output power was reduced 80%. When used in conjunction with an active mirror alignment system, output power of the 1 MW FEL is unaffected.

**KEYWORDS:** Free Electron Laser, Short Rayleigh Length, Directed Energy Weapon, Mirror Stability

# **MASTER OF SCIENCE IN PROGRAM MANAGEMENT**

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## **A UNIQUE PROTOTYPING CONCEPT FOR MISSILE AND AVIATION WEAPON SYSTEMS**

**Ronald E. Chronsiter-DoD Civilian  
B.S., University of Alabama, 1982**

**Master of Science in Program Management-December 2002**

**Advisor: David F. Matthews, Graduate School of Business and Public Policy**

**Associate-Advisor: Richard W. Amos, U.S. Army Space and Missile Defense Command**

This thesis is a case study into the development of a unique prototyping concept to support aviation and missile weapon system requirements. The U.S. Army Aviation and Missile Command has an electrical and mechanical prototyping capability that has existed for twenty-five years, but has been geographically, and functionally separated. These capabilities have been integrated both functionally and geographically into the Prototype Integration Facility, Building 5405, at Redstone Arsenal, Alabama. Aviation and missile program managers are faced with the increased challenge to acquire materiel in a more cost effective, timely manner. The Prototype Integration Facility (PIF) concept builds off the foundation of the existing base of prototyping experience, but integrates unique business principles to form a creative, powerful concept to assist aviation and missile program managers in their quest to rapidly provide materiel to the warfighter. The primary tenants of the PIF concept include the leveraging of existing Governmental and industrial capabilities to provide a cost effective alternative for program managers to utilize. The PIF concept utilizes a ten-year, \$1.1 billion contract, to leverage the capabilities of original equipment manufacturers, capability-specific companies and small businesses. Since implementation of the PIF concept in June 2002, an influx of \$18 million of aviation and missile prototyping business has been achieved.

**KEYWORDS:** Missile Prototyping, Aviation Prototyping, Alternative Acquisition Processes, Aviation Modifications

## **A PROGRAM MANAGER'S GUIDE FOR SOFTWARE COST ESTIMATING**

**Andrew L. Dobbs-DoD Civilian  
B.S., Athens State College, 1990**

**Master of Science in Program Management-December 2002**

**Advisor: Brad Naegle, Graduate School of Business and Public Policy**

**Associate Advisor: Latika Becker, U.S. Army Space and Missile Defense Command**

This thesis will assist current and future program managers by outlining a process to ensure the software cost estimates developed for a system will be credible and supportable throughout the life of the program. This thesis also identifies many of the problems associated with software cost estimating and recommends potential solutions.

One of the critical parameters for estimating software cost is the quantity of source lines of code (SLOC) required in the program. Therefore, this thesis examines the software cost implications of improperly estimating SLOC and function points. Some of the other parameters required to estimate the software cost include language, functionality, application, software processes maturity, programmer skill level, design and reuse, productivity factors, complexity, utilization and schedules. Many of these parameters overlap. For example, both the complexity of the code and skill level of the programmer directly impacts the productivity and schedule of the program.

This thesis provides a broad view of the software cost estimating process. In the reference and appendix section, a list of valuable resources including commercial estimating models is provided for further assistance.

**KEYWORDS:** Software, Cost, Estimating, SLOC, Management, Development, Code, Metric

## **PROGRAM MANAGEMENT**

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### **ACQUISITION OF THREAT-REPRESENTATIVE BALLISTIC MISSILE TARGETS**

**Jerry E. Esquibel-DoD Civilian**

**B.S., New Mexico State University, 1984**

**Master of Science in Program Management-December 2002**

**Advisor: David F. Matthews, Graduate School of Business and Public Policy**

**Associate Advisor: John F. Phillips, Program Executive Office-Air and Missile Defense**

Test and Evaluation of ballistic missile defense systems under development is required to assess system technical performance, design specifications, and maturity, and to determine if the defense systems are operationally effective, suitable, and survivable against the threat(s) identified in the System Threat Assessment Report (STAR). Acquisition of threat-representative ballistic missile targets that emulate threat systems, as detailed in the STARs, are required to test and evaluate defense systems under realistic operational environments. The evolving ballistic missile threat and the increased proliferation of ballistic missile systems have increased the urgency to develop and field missile defense systems capable of defeating all of these threats. Threat-representative ballistic missile targets and Foreign Military Acquisition targets play a critical role in assessing performance capabilities, system maturity, operational effectiveness, suitability, and survivability during developmental and operational test and evaluation of missile defense systems. This research identifies key management challenges experienced since 1990 by current and former target Product Managers and Project Managers. Recommendations are also included concerning how to manage these challenges based upon lessons learned provided by experienced Product Managers and Project Managers.

**KEYWORDS:** Program Management, Ballistic Missile Targets, Consolidated Targets Plan, Missile Defense Targets Joint Project Office, Target Development Process

### **CASE STUDY OF THE DEVELOPMENT OF THE APACHE ATTACK HELICOPTER (AH-64)**

**Edward W. Ference-DoD Civilian**

**B.S., University of Pittsburgh, 1985**

**Master of Science in Program Management-December 2002**

**Advisor: Michael W. Boudreau, Graduate School of Business and Public Policy**

**Associate Advisor: Richard G. Rhoades, University of Alabama, Huntsville**

This research examines advances in aviation technologies that allowed the Apache to become the world's premier attack helicopter. This is one of a series of research pieces, conducted under the auspices of an ongoing research effort sponsored by Headquarters U.S. Army Material Command. The U.S. Army Aviation and Missile Command (AMCOM) has contracted with the University of Alabama in Huntsville (UAH) to do this research. After all of the research is completed, the principal investigators at UAH and Massachusetts Institute of Technology (MIT) will do a crosscutting analysis across all the systems to identify key factors that can be used to guide future decision-making. This thesis presents answers to a structured set of questions that address issues concerning outside influences, technology maturity and program management. It evaluates the role of development and test strategies, and whether these have helped to create a functional system. The research methodology is a Case Study, a limited number of questionnaires were sent to key personnel intimately involved with the program development. This thesis provides the reader with a thorough understanding of how the history of Army aviation has evolved, leading to the requirement for an attack helicopter on the modern battlefield. The emphasis of this document is to follow a major weapon system through its lifecycle, leading to successful deployment. Lessons learned are presented in a clear concise manner addressing issues of prime concern to any size program.

**KEYWORDS:** Acquisition, Apache, Aviation, Funding, Helicopter, Program Management, Requirements, Test and Evaluation, Technology Readiness Levels, TRADOC

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## **PROGRAM MANAGEMENT**

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### **CONTRACTING FOR LIFE-CYCLE CONTRACTOR SUPPORT FOR ARMY TACTICAL MISSILE SYSTEMS**

**Beverly J. Fuller-DoD Civilian**

**B.S., University of Alabama-Huntsville, 1987**

**Master of Science in Program Management-December 2002**

**Advisor: David F. Matthews, Graduate School of Business and Public Policy**

**Associate Advisor: Donald C. Barker, U.S. Army Space and Missile Defense Command**

Government interest has increased in recent years regarding the viability of contracting out for the Life-Cycle Support of military weapon systems. This thesis addresses the legal ramifications and possible contracting avenues that Program Managers could use to obtain support for Army tactical missile systems. Congress has enacted numerous statutes that the Program Manager must adhere to regarding depot maintenance activities when considering Life-Cycle Contractor Support.

Within the Program Executive Office (PEO), Tactical Missiles, two programs have received approval for contracting out support efforts. One program awarded a contract in 2000 and the second is in the planning stages. The potential exists for numerous programs to pursue this avenue for supporting DoD weapon systems.

**KEYWORDS:** Life-Cycle Contractor Support, LCCS, Award Term Contract, Warranty, Cost-Plus, Fixed-price, Incentive Fee, Award Fee, Statutory Requirements, Depot Maintenance, Tactical Missiles, Javelin, Improved Target Acquisition System, ITAS, Supportability

### **AN ANALYSIS OF ARMY PROGRAM MANAGEMENT OFFICE INSERTION INTO THE CENTRAL TEST AND EVALUATION INVESTMENT PROGRAM PROJECT SELECTION PROCESS**

**Margaret F. Haack-DoD Civilian**

**B.I.E., Auburn University, 1983**

**Master of Science in Program Management-December 2002**

**Advisor: Ron Tudor, Graduate School of Business and Public Policy**

**Associate Advisor: LTC Rodney E. Tudor, USA, Graduate School of Business and Public Policy**

The Central Test and Evaluation Investment Program (CTEIP) was established in 1990 by the Office of the Secretary of Defense (OSD), in response to Congressional direction, to provide a corporate investment approach to meeting Service and Defense Agency Test and Evaluation (T&E) needs. This approach to the allocation of test resources increases interoperability between the Services, and interconnectivity among the test centers and ranges. It serves to focus T&E expertise on test requirements that are of the highest priority. The CTEIP project selection process consists of a cyclic approach in which the Services and Defense Agencies solicit T&E needs, propose solutions to those needs, and then formally project proposals. Program Management Offices (PMOs) are not directly solicited for potential project solutions addressing direct operational test needs, yet, the PMOs are facing significantly reduced T&E funding. Knowledge of the CTEIP program and the proposal submission process should aid the PMOs in the planning and execution of their Operational Test Programs. This thesis reviews the CTEIP and evaluates the extent to which PMOs are involved in the submission of T&E needs, and the value of PMO involvement in CTEIP project selection process.

**KEYWORDS:** Test and Evaluation, T&E, CTEIP, T&E Investments, Program Management Office, PMO, TEMA, DOT&E, Funding, Operational Testing, Requirements, Test Needs, T&E Planning



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## PROGRAM MANAGEMENT

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### THE ANALYSIS OF SIMULATION BASED ACQUISITION (SBA) ECONOMIC BREAKPOINTS IN THE LIFECYCLE OF MAJOR PROGRAMS

George R. Hunt, III-DoD Civilian

B.S., University of Wisconsin-Stout, 1984

M.B.A., Pennsylvania State University, 1994

Master of Science in Program Management-December 2002

Advisor: Michael W. Boudreau, Graduate School of Business and Public Policy

Associate Advisor: Robert W. Poor, U.S. Army Space and Missile Defense Command

The research area of this thesis is Simulation Based Acquisition (SBA) and the methods in which it has been implemented into the Department of Defense (DoD). Application of SBA initiatives relies upon the use of modeling and simulation, among other methods, to effectively use scarce resources – funds, manpower, equipment – in the life cycle of major programs. The SBA initiative has been used in the Department of Defense for approximately six years. Accordingly, program managers have employed the techniques of SBA to achieve significant advances while reducing costs. Thus, those resources saved may be used elsewhere in the program. Typically, savings can be realized early in the program life in terms of downstream logistics. Users who have identified Operating and Sustainment (O&S) constraints during the preparation of the Mission Needs Statement should examine the inclusion of SBA during concept exploration and system development. The Department of Defense has provided guidance on the SBA initiative and the methods of SBA are being incorporated into programs. The attempt of this study will not only identify the key points within the program to use SBA, but also how to best employ those methods.

**KEYWORDS:** Simulation Based Acquisition, Modeling and Simulation, Acquisition Life Cycle, Program Management, DoD Directives

### PRIME VENDOR SUPPORT (PVS) FOR THE AVENGER M3P .50 CALIBER MACHINE GUN SYSTEM

Glenn R. McPherson-DoD Civilian

B.S., Southern Polytechnic College, 1981

Master of Science in Program Management-December 2002

Advisor: Michael W. Boudreau, Graduate School of Business and Public Policy

Associate Advisor: Robert D. Overbeek, U.S. Army Space and Missile Defense Command

The United States Department of Defense (DoD) is under pressure to improve the way it does business in order to save money, improve performance, and improve customer satisfaction. Numerous plans and declarations have been initiated in the past, only to be overcome by business as usual. In 1994, Secretary of Defense William Perry initiated Acquisition Reform policies, causing sweeping changes in many areas of acquisition that continue to evolve today. Reform has brought about changes in program planning, specifications, requirements, test and evaluation, systems engineering, and documentation. One area in DoD that has been a challenge for significant change is logistics. It is widely publicized that at least 60 percent of the life-cycle cost of a weapon system is in the years of sustainment after the development and production are complete. With very few new systems in development, ways to improve the reliability and lower the support costs of our legacy equipment must be found. Many pilot programs are now in place and are slowly starting to reap benefits. One program that has received recent attention is Prime Vendor Support (PVS). This thesis will examine the feasibility of Prime Vendor Support (PVS) for the M3P machine gun, a major subsystem of the Avenger air defense platform. Research will include a review of the current M3P support concept, an in-depth study of PVS and examples of where PVS is being implemented, and the advantages and disadvantages of support through PVS.

**KEYWORDS:** Logistics, Prime Vendor Support (PVS), Contractor Logistics Support (CLS), Avenger, Air Defense, Small Arms, Machine Gun

## **PROGRAM MANAGEMENT**

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### **CASE STUDY OF THE DEVELOPMENT OF THE TARGET ACQUISITION DESIGNATION SYSTEM / PILOT NIGHT VISION SYSTEM (TADS/PNVS)**

**Jerome A. Oelrich-DoD Civilian**

**B.S., University of Illinois, 1980**

**Master of Science in Program Management-December 2002**

**Advisor: David F. Matthews, Graduate School of Business and Public Policy**

**Associate Advisor: Richard G. Rhoades, University of Alabama, Huntsville**

This thesis is a case study of the extent to which a series of factors influenced development of the U.S. Army Target Acquisition Designation System/Pilot Night Vision System (TADS/PNVS). This study is one of a series being prepared under an ongoing research effort sponsored by Headquarters U.S. Army Material Command (AMC). These studies will look at various weapon systems that participated in Operation Desert Storm (ODS) and will study the effectiveness of their Development Strategies, for the purpose of later comparing system effectiveness in ODS. The TADS/PNVS was developed for the AH-64A Apache Helicopter, as a sighting system for the Hellfire missile system. This case study focuses on the system's three critical technologies, evaluates their technical maturity at various stages versus Technology Readiness Levels, and analyzes how that affected the later development and testing. The study also highlights funding stability, user involvement, integrated product teams, and testing strategies. The thesis focuses particular attention on testing, and whether testing of the TADS/PNVS system was sufficient and timely during development.

**KEYWORDS:** Acquisition, AH-64, AMC, AMCOM, Bore Sight, Development, IPT, LOSS, Night Vision, ODS, PM, PMO, PNVS, Program Management, Stabilization, TADS, Test, TRADOC, TRL

### **MANAGEMENT OF MICROCIRCUIT OBSOLESCENCE IN A PRE-PRODUCTION ACAT-ID MISSILE**

**William S. Pearce-DoD Civilian**

**B.S., University of Alabama-Huntsville, 1992**

**Master of Science in Program Management-December 2002**

**Advisor: David F. Matthews, Graduate School of Business and Public Policy**

**Associate Advisor: Amy J. Grover, U.S. Army Space and Missile Defense Command**

Microelectronic piece-part component obsolescence problems are prevalent and costly across all Department of Defense (DoD) weapon systems, both new and legacy. The issue is driven by the high turnover in electronic components, limited DoD influence upon component manufacturers, poor obsolescence management at both Program Office and Command levels, and a lack of understanding of the analysis tools and design techniques available to the Program Manager (PM) to help mitigate problems. The issue of microcircuit obsolescence affecting a pre-production, Acquisition Category (ACAT)-ID, Missile program is of particular interest due to their inability to transition from pre-production into full rate production, without a major redesign due to microcircuit obsolescence. The DoD and other governmental agencies, along with commercial industries, are investigating numerous ways to reduce the increasing costs associated with obsolescence. This thesis incorporates this information to provide both the pre-production ACAT-ID Missile Weapon System Program Managers and the U.S. Army Aviation and Missile Command (AMCOM) guidance in addressing microcircuit obsolescence challenges from a management perspective.

**KEYWORDS:** Obsolescence, Missile, Management, Components, Piece-parts



# **MASTER OF SCIENCE IN SOFTWARE ENGINEERING**

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## **SIMPLE: A PROTOTYPE SOFTWARE FAULT-INJECTION TOOL**

**Neil John P. Acantilado-DoD Civilian**

**B.A., University of California-San Diego, 1992**

**Master of Science in Software Engineering-December 2002**

**Christopher P. Acantilado-DoD Civilian**

**B.S., San Diego State University, 1993**

**Master of Science in Software Engineering-December 2002**

**Advisor: James Bret Michael, Department of Computer Science**

**Second Reader: Richard Riehle, Department of Computer Science**

Fault-injection techniques can be used to methodically assess the degree of fault tolerance afforded by a system. In this thesis, a Java-based, semi-automatic fault-injection test harness, called Software Fault Injection Mechanized Prototype Lightweight Engine (SIMPLE) is introduced. SIMPLE employs a state-based fault injection approach designed to validate test suites. It also can assist developers to assess properties of a system such as robustness, reliability, and performance. Furthermore, SIMPLE employs fault acceleration to test a system's fault-tolerant capabilities. An object-oriented analysis of the system and several case studies, using software fault injection on specific, targeted systems, to assess SIMPLE's effectiveness is presented.

**KEYWORDS:** Software Fault Injection, Fault Tolerance, Software Testing, Software Test Coverage, and Metrics



# **MASTER OF ARTS**

**International Security and Civil-Military Relations  
National Security Affairs**



# **MASTER OF ARTS IN INTERNATIONAL SECURITY AND CIVIL-MILITARY RELATIONS**

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## **NATIONAL GUARD ENGAGEMENT IN THE PACIFIC: NO THREAT TO SECURITY**

**Mark C. Bour-Major, Alaska Air National Guard**

**B.S., Eureka College, 1985**

**M.S., University of La Verne, 1998**

**Master of Arts in International Security and Civil-Military Relations-December 2002**

**Advisor: H. Lyman Miller, Department of National Security Affairs**

**Second Reader: Paul N. Stockton, Department of National Security Affairs**

This thesis evaluates recent decisions to expand the National Guard (NGB) State Partnership Program into the Asia-Pacific region and examines potential effects this expansion will have on the new partners created there. It predicts likely responses from non-participants and defends the program against critics who argue that engagement activities draw personnel and resources away from primary war fighting objectives. It examines European engagement programs developed through NATO in the mid-1980s, assessing their evolution and present activities. Specifically, the Partnership for Peace (PfP) and the National Guard's State Partnership Program (SPP) are addressed. This evaluation provides a foundation for prescribing changes to the SPP doctrine for future relationships throughout the Asia-Pacific region. From this evidence the main body of work focuses on predictions of applying this regionally specific model. It looks particularly at evolutionary characteristics needed to make the program feasible, discussing current partnerships and those countries awaiting future consideration. Mongolia is addressed in detail, being the newest member country petitioning for partnership. Finally, and most important, the extent to which the program affects regional stability is assessed, focusing specifically on China as it ushers in its fourth generation of leadership and continues to open itself to the outside world.

**KEYWORDS:** National Guard, Engagement Programs, Asia-Pacific, China, Mongolia

## **MAKING THE CONNECTION: CIVILIAN-TO-CIVILIAN INITIATIVES IN THE NATIONAL GUARD STATE PARTNERSHIP PROGRAM**

**Albert T. Gorman-Captain, United States Army National Guard**

**B.S., Excelsior College, 1998**

**B.S., Michigan State University, 2001**

**Master of Arts in International Security and Civil-Military Relations-December 2002**

**Advisor: Robert Looney, Department of National Security Affairs**

**Second Reader: Lois Roberts, Department of National Security Affairs**

The National Guard State Partnership Program (SPP), a partnership between a State National Guard and another country, is now in its tenth year. Many of these relationships have moved beyond military-to-military engagement activities and into civilian-to-civilian initiatives. These civilian led initiatives seek to leverage the assets of a particular State in support of the partner country. As the SPP matures, it is the goal of most states to realize this lifecycle of the partnership culminating in civilian-to-civilian programs. How the states can get there is the purpose of this thesis. This thesis assesses the tenets of success that have made economic development (ED) and social development (SD) initiatives within the Maryland and Estonian relationship successful. It also studies how the Sister Cities International relationship of La Crosse, Wisconsin, and Dubna, Russia has achieved a level of success that many partnerships in that program seek as a goal. Additionally, this thesis creates a "road map" for states contemplating ED/SD projects. Finally, it accesses the SPP's ability to create social capital, which, in turn, contributes to an increase in the economic and/or social "bottom line" of the partners.



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## **INTERNATIONAL SECURITY AND CIVIL-MILITARY RELATIONS**

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**KEYWORDS:** National Guard, State Partnership Program, Sister Cities, Social Capital, Engagement, Transnational, Health Care, Education, International

### **THE U.S. MILITARY AND SECURITY ALONG THE U.S.-MEXICO BORDER: EVALUATION OF ITS ROLE IN THE POST SEPTEMBER 11<sup>TH</sup> ERA**

**Benjamin Carl Luoma, Jr. -Major, United States Army**

**B.A., University of Phoenix, 1997**

**Master of Arts in International Security and Civil-Military Relations-December 2002**

**Advisor: Jeanne K. Giraldo, Department of National Security Affairs**

**Co-advisor: Harold A. Trinkunas, Department of National Security Affairs**

This thesis examines the use of the U.S. Armed Forces in civil authority support missions along the U.S.-Mexico border from the creation of the boundary between the U.S. and Mexico in 1848, to the post-September 11<sup>th</sup> border security support operations. Many questions arise from using the military in this capacity, for example; how effective is the military's support to civil authorities (MSCA), can the military perform MSCA operations without the threat to humans and the rights of civilians, how do MSCA missions such as these impact the combat readiness of the military? This thesis found that military support to civil authorities was indeed effective, especially with in cases where non-federalized National Guard personnel were employed. It also shows that the military has implemented control measures that enable troops to conduct law enforcement support missions while respecting the human and civil rights of civilians. Lastly, it found that the combat readiness of the military was not necessarily diminished, but could actually be enhanced during MSCA operations.

**KEYWORDS:** Militarization, Military Support to Civil Authorities, MSCA, U.S.-Mexico Border, Law Enforcement, Military, National Guard

### **IMPROVING REGIONAL SECURITY IN CENTRAL AMERICA: MILITARY ENGAGEMENT OPTIONS FOR NICARAGUA**

**George W. Mason-Captain, Wisconsin Army National Guard**

**B.S., University of Wisconsin-Green Bay, 1995**

**Master of Arts in International Security and Civil-Military Relations-December 2002**

**Advisor: Harold A. Trinkunas, Department of National Security Affairs**

**Second Reader: Jeanne K. Giraldo, Department of National Security Affairs**

In this thesis, the past, present, and future role of Nicaragua in the stability and security of the Central American sub region is examined. Relations over the last twenty years between Nicaragua, the countries in the sub region, and the U.S. have been tense. The breakdown of confidence-building measures necessitates a detailed analysis to determine those confidence-building measures that will likely succeed in the future. Nicaraguan national security goals are filtered through a framework of analysis to determine which confidence-building measures will be most effective in reducing tensions in the sub region. U.S. involvement and participation in re-establishing confidence-building measures in the sub region is needed. Recommendations include the implementation of a comprehensive military engagement plan in order to foster stability and security in the sub region and strengthen U.S.-Nicaraguan relations.

**KEYWORDS:** U.S., Nicaragua, Central America, Security, Confidence-building Measures, SOUTHCOM, National Guard State Partnership Program, Military Engagement

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# **INTERNATIONAL SECURITY AND CIVIL-MILITARY RELATIONS**

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## **THE ROLE OF INTERNATIONAL JURIDICAL INSTITUTIONS IN INTERNATIONAL SECURITY AND CIVIL-MILITARY RELATIONS**

**Stavros Polydorou-Lieutenant, Hellenic Navy  
B.S., Hellenic Naval Academy, 1992**

**Master of Arts in International Security and Civil-Military Relations-December 2002**

**Advisor: James Holmes Armstead, Naval War College**

**Co-Advisor: Thomas Bruneau, Department of National Security Affairs**

This thesis answers the following question: "Does the practice and theory of modern Transnational Juridical Institutions impact upon the development and maintenance of International Security within the complex of the Civil Military relation's paradigm, and if so, how?" Therefore it examines the effects of International Juridical Institutions upon the relations between civil authorities and the military structure within modern states. Since 1945 the international community has constituted four ad hoc tribunals, namely the International Military Tribunal at Nuremberg, the International Military Tribunal for the Far East, the International Criminal Tribunal for Yugoslavia, and the International Criminal Tribunal for Rwanda. Their mandate was to bring to justice those who have committed grave breaches of international law by the waging of aggressive war, crimes against humanity, war crimes, genocide, and crimes against peace; crimes committed with the use of the military. Their jurisprudence significantly challenged the relations between the military the state and the society not only in the state they had or have jurisdiction but worldwide. They have affected constitutions, attitudes, education, training, roles and missions of the military and posed limitations to the state by influencing domestic or international social and legal order. These changes within the civil-military relations and international security promoted by these international criminal courts highlight that international justice could be used as a useful political instrument. Hence, they were a success. However, the current political debate under the new permanent International Criminal Court reveals that systemic international justice has not matured yet to meet the needs of a world equipped with a plethora of weapons and highly sophisticated weapons of destruction that could allow for horrific crimes.

**KEYWORDS:** International Law, International Criminal Law, Transnational Juridical Institutions, International Security, Civil-Military Relations, International Military Tribunal at Nuremberg, International Military Tribunal for the Far East, International Criminal Tribunal for Yugoslavia, International Criminal Tribunal for Rwanda, International Criminal

## **THE NATIONAL GUARD STATE PARTNERSHIP PROGRAM: A COMPARATIVE ANALYSIS BETWEEN THE CALIFORNIA NATIONAL GUARD AND THE MISSOURI NATIONAL GUARD**

**Ellen J. Reilly-Major, Arizona Army National Guard  
B.S., Indiana University of Pennsylvania, 1990**

**Master of Arts in International Security and Civil-Military Relations-December 2002**

**Advisor: Harold A. Trinkunas, Department of National Security Affairs**

**Second Reader: Paul N. Stockton, Department of National Security Affairs**

This thesis assesses the U.S. National Guard State Partnership Program through a review of the current and historic interaction between two of thirty-four States: the California National Guard and Ukraine partnership and the Missouri National Guard and Panama Partnership. The two sets of Partnerships are critically analyzed in light of arguments in favor of and arguments against utilizing the U.S. National Guard to conduct the State Partnership Program. Ultimately, it is determined that the National Guard is the only entity capable of bringing together all the key civilian and military players necessary to make the State Partnership Program a success. The thesis presents lessons learned from the last decade along with recommendations for future interaction and research.

**KEYWORDS:** U.S., Panama, Ukraine, Missouri, California, National Guard State Partnership Program, Military Engagement

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## **INTERNATIONAL SECURITY AND CIVIL-MILITARY RELATIONS**

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### **RUSSIAN INFLUENCE ON NATO MEMBER/NON-MEMBER RELATIONSHIPS: A CASE STUDY OF THE U.S.-UKRAINE MILITARY TO MILITARY RELATIONSHIP**

**Joseph D. Righello-Lieutenant Colonel, California Army National Guard  
B.A., Saint Mary's College of California, 1993**

**Master of Arts in International Security and Civil-Military Relations-December 2002**

**Advisors: Mikhail Tsypkin, Department of National Security Affairs**

**Jeff Knopf, Department of National Security Affairs**

This thesis explores Russia's attempts to influence NATO bilateral relationships between members and non-members (partners) and examines the U.S.-Ukraine military-to-military program as its case study. The thesis begins by describing Russia's relations with NATO, centering on NATO enlargement and its role in the NATO-Russia relationship. It then examines the U.S.-Ukraine relationship, with a specific eye toward military-to-military relations and examples of Russian influence on that relationship. It then further describes Russian influence on U.S.-Ukraine relations, Russia-Ukraine relations and, Russia-U.S. relations. The thesis recommends improving the existing U.S.-Ukrainian military-to-military relationship by continuing the engagement and security cooperation activities. It points to the special relationship that Ukraine enjoys with both NATO and the United States and underscores the importance of continued good relations.

**KEYWORDS:** Russian Relations with NATO, U.S.-Ukrainian Military Relations, International Relations-Russia, Russian-U.S. Relations, U.S.-Russian Relations, Foreign Military Relations

### **THE ROLE OF THE ARMY NATIONAL GUARD IN THE 21<sup>ST</sup> CENTURY: PEACEKEEPING VS. HOMELAND SECURITY**

**Spencer W. Robinson-Major, United States Army National Guard  
B.S., United States Military Academy, 1989**

**Master of Arts in International Security and Civil-Military Relations-December 2002**

**Advisor: Harold A. Trinkunas, Department of National Security Affairs**

**Second Reader: Paul N. Stockton, Department of National Security Affairs**

In this thesis, the role of the National Guard in supporting current National Security and National Military Strategy is examined. It is argued that the global security environment has changed drastically since the end of the Cold War, making "Homeland Security" a primary mission for the military, specifically the National Guard. Concurrently, the unprecedented number of overseas deployments to perform peacekeeping missions has severely affected the active Army's combat capability. It is argued that the U.S. Army has not embraced the requirements for "Homeland Security," focusing instead on maintaining its 10 active division force structure. To meet the needs of National Military Strategy, the active Army has instead relied on the reserve components to perform overseas peacekeeping missions. It is argued that the National Guard has also looked to performing these missions as a method of institutional survival. Together, both components have undermined the Constitutional underpinnings of the Reserve Component as a strategic reserve, to be mobilized in cases of "war or national emergency." It is argued that making "Homeland Security" a primary federal mission of the National Guard, along with restructuring current combat, combat support, and combat service support ratios will allow the National Guard to support National Military Strategy and "Homeland Security."

**KEYWORDS:** U.S. Constitution, U.S. National Security Strategy, U.S. National Military Strategy, Quadrennial Defense Review (1997), Reserve Component Employment, Homeland Security

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## **INTERNATIONAL SECURITY AND CIVIL-MILITARY RELATIONS**

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### **INTELLIGENCE NETWORKS AND THE TRI BORDER AREA OF SOUTH AMERICA: THE DILEMMA OF EFFICIENCY VERSUS OVERSIGHT**

**Eric G. Wishart-Captain, Nevada Army National Guard**

**B.A., University of Nevada-Reno, 1993**

**Master of Arts in International Security and Civil-Military Relations-December 2002**

**Advisor: Thomas Bruneau, Department of National Security Affairs**

**Second Reader: Harold A. Trinkunas, Department of National Security Affairs**

This thesis examines the intelligence communities of Argentina, Brazil, and Paraguay to determine how to better coordinate and share information between themselves and the United States to combat the emerging threat of terrorism within the border region shared by the three Latin American countries. The thesis argues from the standpoint that the primary intelligence effort should be economic and HUMINT due to the currently low threat levels, and that the threat should be handled by civilian agencies. It examines each community based on an "Ideal Type" intelligence community model that balances efficient, competitive, all-source intelligence organizations with oversight at the various levels. The thesis also examines U.S. foreign policy in the region to determine if it has helped or hindered each country's intelligence community to better align itself with the ideal type model. It concludes with policy recommendations for the United States to develop better bilateral relationships with each country, as well as recommendations to help to form a regional coordination initiative that will allow multilateral intelligence sharing.

**KEYWORDS:** Terrorism, Intelligence, South America, Argentina, Brazil, Paraguay

### **BUILDING UP A STRATEGY FOR DE-BALKANIZING THE BALKANS: STABILITY AND PROSPERITY IN SOUTHEASTERN EUROPE**

**Ferdinand Xhaferaj-Albanian Parliament**

**B.A., Tirana State University, 1988**

**Master of Arts in National Security Affairs-December 2002**

**Master of Arts in International Security and Civil-Military Relations-December 2002**

**Advisor: Donald Abenheim, Department of National Security Affairs**

**Second Reader: Robert Looney, Department of National Security Affairs**

Almost three years after the Kosovo conflict, the Balkans remains politically and socially unstable as well as economically depressed. Even though Slobodan Milosevic has gone, he has left behind him a legacy of destruction and distrust. The mechanisms, instruments, and models of international relations that provide a framework for producing security and promoting development such as creation of alliances, diplomacy, and models of security communities, did not produce the expected results. Therefore, a high potential for renewed conflict remains acute. Across the Balkans, integration and stability are still in their infancy due to strong nationalism and under-performing economies. Taking into consideration that complex crises such as that in the Balkans usually have their origin in long-term circumstances, it is understandable that investigating the long-term, deep historical roots of a conflict is important in identifying possible solutions. One of the main reasons that Western Powers adopted a reluctant attitude towards the Balkans crises, or did too little too late, was misunderstanding the nature and the origin of the conflicts from the beginning. Without knowing where the region is coming from, it is impossible to construct where the region should be heading. This thesis outlines a brief history of the region that provides the context for the current situation. It demonstrates the impact of ethnicity, religion, language, culture, and economics in shaping the conflicts in the Balkans. Furthermore, it analyzes the current security and economic situation in the region. Finally, it provides some security and economic recommendations, which offer guidelines for implementing what the author considers the right path for de-Balkanizing the Balkans.

**KEYWORDS:** Balkans, South Eastern Europe, Conflict, Transition, Stabilization



# **MASTER OF ARTS IN NATIONAL SECURITY AFFAIRS**

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## **CHRISTIAN THEOLOGICAL ATTITUDES VIS-À-VIS ISLAM: THE EFFECT ON WEST-MUSLIM RELATIONS**

**Robert T. Bryans, Jr.-Lieutenant, United States Navy  
B.A., Old Dominion University, 1996**

**Master of Arts in National Security Affairs-December 2002**

**Advisors: Glenn E. Robinson, Department of National Security Affairs  
Kenneth J. Hagan, Naval War College**

Since the end of the Cold War two debates have largely shaped Western views of Islam: Islam's relevance in statecraft and the potential "clash of civilizations" between Islam and the West. Those joined in these debates argue that just as the West seeks to explain Islam's relevance and role in a potential "clash of civilizations," the West must also examine its own historical experience with religion and statecraft and find ways of looking at itself through the eyes of the Islamic world. This thesis achieves this examination of historical experience and self-reflection by contributing what has long been missing from the debates: an understanding of Christian theological attitudes vis-à-vis Islam and the effect of those attitudes on West-Muslim relations. The argument presented is that while religion is generally forgotten in the West it remains a driving force in the Muslim world, where nearly everything has religious overtones. This thesis explores Christian theological attitudes beginning with the development of historical Orthodox Christianity, Christian theological objections to Islam, the application of theology in the greater context of West-Muslim relations as well as the current impact of Christian theological attitudes on Christian-Muslim relations and their impact on West-Muslim relations.

**KEYWORDS:** Christianity, Christian Theology, Christian-Muslim Relations, West-Muslim Relations, Islam, Islamic Theology, Clash of Civilizations, Religion, Statecraft

## **HUMAN RIGHTS IN SINO-AMERICAN RELATIONS**

**Jana R. Day-First Lieutenant, United States Air Force  
B.S., United States Air Force Academy, 1999**

**Master of Arts in National Security Affairs-December 2002**

**Advisor: H. Lyman Miller, Department of National Security Affairs  
Second Reader: Gaye Christoffersen, Department of National Security Affairs**

Over the past decade, numerous issues largely ignored during the era of Sino-American strategic cooperation emerged to complicate U.S.-China relations. Key among these has been human rights, which both countries view differently. Whereas the United States emphasizes individual civil and political liberties, the People's Republic of China (PRC) primarily advocates economic, social, and cultural rights. This has provided a major source of conflict as Washington has attempted to compel Beijing to provide civil and political liberties to the Chinese people, which Beijing has long withheld in order to preserve power. These differences, combined with a lack of consensus in Washington regarding China policy, the influence of competing interest groups, and the dilemma policymakers face between protecting national interests and upholding American values, makes human rights difficult to address. This thesis addresses why human rights are such a controversial topic in Sino-American relations and why it is a difficult issue for policymakers to address. It then offers recommendations regarding a more effective policy approach to human rights improvements in China. The United States should emphasize China's obligation, as a responsible member of the international community, to comply with international human rights standards. Most importantly, Washington must take a strong and consistent stance on the issue. This is particularly true given Beijing's recent attempts to use the international war on terrorism to legitimize its repressive policies in Xinjiang. Through a case study of recent events and policies affecting the Xinjiang Uyghur

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Autonomous Region (XUAR), this thesis also assesses the impact of the on-going American "war on terrorism" on the issue of human rights in Sino-American relations.

**KEYWORDS:** China, People's Republic of China (PRC), United States (U.S.), Sino-American Relations, U.S.-China Relations, Human Rights, Uyghur Xinjiang Autonomous Region, War on Terrorism, Xinjiang, Uyghurs, Uyghur, U.S. China Policy, Human Rights Policy

### **CHECHNYA AND RUSSIA: CONFLICT AND SELF-DETERMINATION**

**Brett A. Garvie-Lieutenant, United States Navy**

**B.S., Eastern Michigan University, 1996**

**Master of Arts in National Security Affairs-December 2002**

**Advisor: David Yost, Department of National Security Affairs**

**Second Reader: Mikhail Tsypkin, Department of National Security Affairs**

The current Russo-Chechen conflict illustrates the persistent tension between the principles of national self-determination and territorial integrity. Russia and Chechnya remain engaged in a centuries-old struggle with no foreseeable end. Many Chechens assert that they are continuing the struggle to break free of Russian oppression which began over two centuries ago. Indeed, Chechens have compared their struggle for national self-determination to that of the United States in 1776. In contrast, Russians argue that they have the right to protect and preserve their country's territorial integrity. In an effort to gain support from foreign observers, Russia has portrayed its struggle in Chechnya as part of the fight against international terrorism. Reaching an acceptable political solution would require compromises regarding the fundamental principles as well as the security and economic interests at stake.

**KEYWORDS:** Chechnya, Chechen War, Russia, Self-determination, Territorial integrity, Terrorism

### **RUSSIAN RELATIONSHIPS WITH THE WEST: THE IMPLICATIONS FOR MILITARY REFORM**

**Jeremy Gray-Lieutenant, United States Navy**

**B.S., United States Naval Academy, 1996**

**Master of Arts in National Security Affairs-December 2002**

**Advisor: Mikhail Tsypkin, Department of National Security Affairs**

**Second Reader: Douglas Porch, Department of National Security Affairs**

This thesis examines the impact of NATO-Russia relations on the process of military reform in the Russian Federation. The military reform process within Russia that aims to create a lean, professional military that Russia can afford and that will better serve Moscow's defense needs is hampered by a lingering perception of a threat from the United States and NATO, despite significant evidence to the contrary. A reformed military would reduce the burden on Russia's economy and would be better matched to the immediate and future security needs of the Russian state. A cooperative relationship between Moscow and the West could help to ease the perception of a threat posed by NATO. This could encourage the creation of a Russian military capable of joint operations with Western militaries, especially in the realm of counter-terrorism and peacekeeping operations. A military reformed along these lines could serve as a cornerstone for a strengthened Russian democracy that would allow Russia to become, once again, a player on the world stage. A willingness by NATO and the United States to pursue increased military and political cooperation with Moscow offers an opportunity to influence positively the military reform process within Russia.

**KEYWORDS:** Russian Military Reform, NATO, National Security Strategy, Military Doctrine



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### **BALANCE OF POWER AND THE PROSPECTS FOR PEACE: THE CASE OF THE LEVANT**

**Ryan J. Green-Lieutenant, United States Navy**

**B.S., University of Utah, 1997**

**Master of Arts in National Security Affairs-December 2002**

**Advisor: Glenn E. Robinson, Department of National Security Affairs**

**Second Reader: Karen Guttieri, Department of National Security Affairs**

Over the past 50 years, the Levant has seen more political violence than any other region in the world. This thesis argues that the root cause of this violence is the vast imbalance of power between Israel and its neighbors. Such an imbalance naturally leads to the more powerful country – in this case, Israel – to resort to force in pursuing Israeli interests. Similarly, the imbalance of power acts as a constant reminder of humiliation for the less powerful, compelling these actors to seek to right the imbalance through the use of more unconventional warfare. The end result of power imbalance is perpetual conflict. This thesis focuses on the imbalance of power between Israel and Syria as measured through both military and economic might. This imbalance has been expressed in differing forms of violence by both sides.

**KEYWORDS:** Balance of Power, Israel, Syria, Military, Economy, Conflict

### **ROK-U.S. SECURITY RELATIONS: "THE CHINA FACTOR" AND A TURNING POINT**

**Sung Min Kim-Captain, South Korean Army**

**B.S., Korea Military Academy, 1992**

**Master of Arts in National Security Affairs-December 2002**

**Advisor: Edward A. Olsen, Department of National Security Affairs**

**Second Reader: H. Lyman Miller, Department of National Security Affairs**

This thesis examines the "China factor" in the evolution of the ROK-U.S. relationship and its implications on ROK-U.S. security relations. While the "China factor" had been one of the major stimuli to maintaining a tight alliance relationship between Seoul and Washington during the Cold War era, the recently increasing importance of China in South Korea's strategic calculations has become a major detrimental factor to ROK-U.S. security relations since the end of the Cold-War. Despite the recently aggravated disharmony between the ROK and the United States on their North Korea policies, the ROK-U.S. security alliance still remains intact and plays a crucial role in stabilizing Northeast Asia as well as the Korean peninsula. Within this context, the most favorable sets of policy options for the ROK and the United States regarding bilateral security relations seem to have significant convergence as well as some divergence. Facing a critical turning point of bilateral security relations, both the ROK and the United States will highly benefit from enhancing security cooperation while narrowing the policy gap between the two. The areas for further cooperation include the bilateral alliance, North Korea policy, anti-Americanism, multilateralism, and China policy.

**KEYWORDS:** Alliance, Security Relations, China Factor, Northeast Asia, Korean Peninsula

### **U.S. SECURITY POSTURE IN THE MIDDLE EAST: NEED FOR A CHANGE?**

**Bart W. Logue-Captain, United States Marine Corps**

**B.S., Wayland Baptist University, 1994**

**M.S., National University, 1998**

**Master of Arts in National Security Affairs-December 2002**

**Advisor: Glenn E. Robinson, Department of National Security Affairs**

**Co-Advisor: James Russell, Department of National Security Affairs**

The United States forward military presence in the Middle East has been on the rise for well over a decade. Recent polling data has indicated that favorable Arab public opinion of the United States and its foreign policy is in decline. This thesis explores the unfavorable opinions of the Arab world toward U.S. foreign policies, utilizing data from recent polls taken in several countries in the Middle East, and suggests a causal



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relationship between the development of unfavorable opinion in the Arab world with the growth of the U.S. forward military presence in the region. This research provides a breakdown of the growth of the U.S. military footprint in the Middle East over the last two decades. The research presented provides an overview of how U.S. foreign policy toward the Middle East has developed and argues the necessity of reform in the current U.S. strategic approach toward the Middle East.

**KEYWORDS:** Middle East, Security Strategy, Public Opinion, Forward Presence, Engagement

### **THE FREE TRADE AREA OF THE AMERICAS: CAN REGIONAL ECONOMIC INTEGRATION LEAD TO GREATER COOPERATION ON SECURITY**

**Thomas M. Sandoval-Lieutenant, United States Navy**

**B.S., University of Texas-San Antonio, 1995**

**Master of Arts in National Security Affairs-December 2002**

**Advisor: Harold A. Trinkunas, Department of National Security Affairs**

**Second Reader: Peter R. Lavoy, Department of National Security Affairs**

The purpose of this thesis is to assess U.S. policies favoring the passing and implementing the Free Trade Area of the Americas (FTAA) and its impact on cooperative security in the Western Hemisphere. Similar to the 1990s, when the U.S. government debated the pros and cons of the NAFTA, the United States now faces a debate over passage and implementation of the FTAA. With many U.S. and Latin American citizens' focus on economic domestic issues, FTAA talks have widely contested among non-governmental organizations, governmental organizations, labor, and social groups, and the legislative and executive branches of the United States and Latin American governments. This thesis argues the economic policies can influence security policies for economically integrated countries and lead to greater regional cooperation on security. The increasing level of transnational threats, pressure from new actors in favor of establishing stability, and the weakening state role stemming from the free market environment and democratic reform encourages a spillover effect in establishing more coordinated security strategies for the threats associated with economic integration. Therefore, economic integration can lead to greater cooperation on security and it can be argued that the United States and Latin America should pass and implement the FTAA as one means to improve collective security.

**KEYWORDS:** FTAA, Economics, Integration, Cooperation, Security, Spillover

### **BREAKING CONSENSUS: THE OCCUPATION AND THE ISRAEL DEFENSE FORCES**

**Leon B. Scratow-Lieutenant, United States Naval Reserve**

**B.A., Carnegie-Mellon University, 1997**

**Master of Arts in National Security Affairs-December 2002**

**Advisor: Glenn E. Robinson, Department of National Security Affairs**

**Second Reader: Jeff Knopf, Department of National Security Affairs**

With the establishment of universal conscription into the Israel Defense Forces (IDF) and reserve duty lasting much of the average male's adult life, the IDF became one of the central institutions of the State of Israel. The occupation of the West Bank, Gaza, East Jerusalem, the Sinai, and Golan in 1967, forced Israelis to re-examine their deeply shared, or hegemonic views about security, peace, and war, especially regarding the employment of the IDF. This thesis examines the effects of Israeli political divisions, specifically with regard to the occupied territories, and further, how those political cleavages affect the employment of the IDF. Its first case study examines the progression of selective refusal to serve in the IDF from the extreme left of the Israeli political spectrum to the center-left, from the Lebanon War through the current uprising. The second case study examines the relationship between the IDF and Fundamentalist Jewish settlers in the Occupied Territories, emphasizing resistance to settlement removal over time. This thesis concludes with prescriptions for redefining the borders of the State of Israel in order to prevent a loss of consensus regarding the legitimacy of the state from the right or the left of the political spectrum.

**KEYWORDS:** Israel, IDF, Occupied Territories, Selective Refusal, Jewish Fundamentalism

## **NATIONAL SECURITY AFFAIRS**

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### **CHINA'S NAVAL MODERNIZATION AND IMPLICATIONS FOR THE SOUTH CHINA SEA**

**Page E. Small-Lieutenant, United States Naval Reserve**

**B.A., University of Oklahoma, 1996**

**Master of Arts in National Security Affairs-December 2002**

**Advisor: H. Lyman Miller, Department of National Security Affairs**

**Second Reader: Randall J. Hess, Naval War College**

This thesis analyzes the implications of Chinese navy modernization for the South China Sea. The PRC is modernizing and expanding its naval capacities for the purpose of protecting China's security, territorial, and economic interests. The PRC has placed a great deal of emphasis on modernizing its navy since the early 1990s. Specifically, Beijing has been purchasing Russian conventional naval arms designed to defeat and counter U.S. naval forces in the region. The transformation of China's navy from a coastal defense force to a blue water fleet capable of projecting force at sea will have serious economic, political, and security implications for the United States, as well as for those countries bordering China and the South China Sea.

**KEYWORDS:** PLA-Navy, PLAN Modernization, South China Sea, China's Naval Modernization, Chinese Navy, Asia-Pacific Region

### **ASSESSING THE RISK OF INADVERTENT NUCLEAR WAR BETWEEN INDIA AND PAKISTAN**

**Stephen A. Smith-Major, United States Army**

**B.A., Evergreen State College, 1989**

**Master of Arts in National Security Affairs-December 2002**

**Advisor: Peter R. Lavoy, Department of National Security Affairs**

**Second Reader: Surinder Rana, Department of National Security Affairs**

Conventional warfare between India and Pakistan could inadvertently escalate to nuclear warfare. Asymmetries in military doctrine and capability undermine deterrence stability and could lead to the use of nuclear weapons if the two nations become engaged in a large-scale conventional conflict. Following the 1998 nuclear weapons test, the 1999 Kargil Conflict played out under the nuclear umbrella, but remained very limited. However, there is a growing gap in conventional military capabilities, and growing pressure in India to retaliate against Pakistan for its alleged support of terrorism and insurgency. India has invested heavily in force modernization, potentially changing the scope of conventional military operations and leading to Pakistan's inadvertent use of nuclear weapons. This thesis examines the possibility of inadvertent nuclear escalation between India and Pakistan. It analyzes the deterrence system that is evolving in South Asia, and describes the conditions under which the system could fail. Large-scale conventional war could threaten the survival of strategic forces, or threaten vital strategic command and control functions. Finally, Pakistan could adopt a launch-on-warning posture to guard against an Indian pre-emptive attack. This thesis concludes by recommending steps that the United States could take to ensure peace and decrease de-stabilizing factors in the region.

**KEYWORDS:** India, Pakistan, United States, Nuclear Weapons, Ballistic Missiles, Deterrence, Escalation

## **NATIONAL SECURITY AFFAIRS**

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### **BUILDING UP A STRATEGY FOR DE-BALKANIZING THE BALKANS: STABILITY AND PROSPERITY IN SOUTHEASTERN EUROPE**

**Ferdinand Xhaferaj-Albanian Parliament**

**B.A., Tirana State University, 1988**

**Master of Arts in National Security Affairs-December 2002**

**Master of Arts in International Security and Civil-Military Relations-December 2002**

**Advisor: Donald Abenheim, Department of National Security Affairs**

**Second Reader: Robert Looney, Department of National Security Affairs**

Almost three years after the Kosovo conflict, the Balkans remains politically and socially unstable as well as economically depressed. Even though Slobodan Milosevic has gone, he has left behind him a legacy of destruction and distrust. The mechanisms, instruments, and models of international relations that provide a framework for producing security and promoting development such as creation of alliances, diplomacy, and models of security communities, did not produce the expected results. Therefore, a high potential for renewed conflict remains acute. Across the Balkans, integration and stability are still in their infancy due to strong nationalism and under-performing economies. Taking into consideration that complex crises such as that in the Balkans usually have their origin in long-term circumstances, it is understandable that investigating the long-term, deep historical roots of a conflict is important in identifying possible solutions. One of the main reasons that Western Powers adopted a reluctant attitude towards the Balkans crises, or did too little too late, was misunderstanding the nature and the origin of the conflicts from the beginning. Without knowing where the region is coming from, it is impossible to construct where the region should be heading. This thesis outlines a brief history of the region that provides the context for the current situation. It demonstrates the impact of ethnicity, religion, language, culture, and economics in shaping the conflicts in the Balkans. Furthermore, it analyzes the current security and economic situation in the region. Finally, it provides some security and economic recommendations, which offer guidelines for implementing what the author considers the right path for de-Balkanizing the Balkans.

**KEYWORDS:** Balkans, South Eastern Europe, Conflict, Transition, Stabilization

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